POWER

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The Share of Labor

I TRIED to show last week that all that makes life possible and enjoyable is the result of human labor and that the more efficiently the labor of a nation is employed and the more economically the products of the labor are used, the higher the plane upon which its people can live with the same amount of toil.

The thought is worth following further.

Here is an expensive machine, the purpose of which is to make shoes. In its natural lifetime it will make only so many shoes and each pair must be charged with its proportion of the cost of the machine. The money invested in it must earn interest on itself. There are taxes and insurance to pay on it. It must pay its part of the rent of the shop that it occupies, light, heat, watchmen, administration, etc. If it makes only one-half the possible number of shoes, each pair will cost for labor and for these overhead expenses twice as much as it ought to, and if the profit is based upon cost the selling price will be doubled.

But there are operators of machines and processes of which this is typical who—through a mistaken sense of personal advantage and of loyalty to their fellow workmen—make the machine turn out as little product, of as poor a quality as possible and use up as much material as they can in doing it.

To their limited vision they gain by giving as little of their labor for the stipulated wage as they can and keep their jobs. If they do more, they think that they are not only exerting themselves unnecessarily, but keeping some other workman out of a job, or—more selfishly—increasing the available supply of labor in their own field and thus inviting a lowering of their own wages. If they waste material, they are making more jobs for their fellows who make it. If they make shoes that will not last more than half as long as those made with more honest craftsmanship, they will be less likely to work themselves out of a job, and the bidding for their labor will be more lively.

What they do in effect is to make their own shoes cost more; to increase the amount of work that the nation as a whole must do to keep itself comfortably shod. And if the same considerations are applied to the other things that go to make up the cost of their living, they are simply making their own livelihood more expensive.

If the profit is proportional to the cost, labor has it in its power to fix the selling price. It cannot better its condition by shirking and sabotage. That only makes everything cost everybody more; makes it necessary for mankind to work harder and longer to live upon the same scale.

Everybody who works on things for which you pay is working for you. You pay him through his employer. If he is a slacker, it is your money that he is wasting, whoever owns the shop he works in and signs the check for the payroll.

What does make a difference is the proportion of the ultimate selling price that labor receives for its contribution. This determines how much one can buy, what kind of a living he can get for the work that he does.

If labor would be contented with fewer dollars per day, but dollars that would go proportionately farther, and insisted that profits be reduced in the same measure, everybody but the profiteer would be better off. The cutting in half of the price of the necessities, comforts, conveniences and pleasures of life would mean more to labor than the doubling of wages, for it would double the purchasing power of its savings and make attractive and practicable the financing of many enterprises which would offer to labor new opportunities in their prosecution and new advantages in their fruition.

F. R. Low

High-Pressure Oil-Burning Installation

Boiler Plant of the Fall River Electric Light Company Converted from Coal to Oil Burning

THIS 15,000-kw. plant, with boilers having a total heating surface of 52,000 sq.ft., was partly changed over from coal to oil burning during the summer of 1920 and was entirely converted to oil burning by the last of August. Fig. 1 shows the present appearance of the boiler room. The equipment consists of Babcock & Wilcox Lodi type of mechanical burners; Blake-Knowles duplex vertical-type pumps good for 300 lb. pressure; Whitlock coil heaters with steel shells good for 200 lb. steam pressure, and the Merit automatic control system for the regulation of the dampers and the oil atomizers.

In making the layout for the oil-burning equipment, one of the main considerations, due to the continuity of service required, was to have a system as flexible and troubleproof as possible. In following out this idea, service tanks, pumps, heaters and suction lines were installed in duplicate and a ring system made of the main oil feed and return lines. The above-ground steel service tanks shown in Fig. 2 are 30 ft. in diameter, 12 ft. high, of 1,500 bbl. capacity. They are 150 ft. away from the boiler plant and as a further protection from fire each tank is surrounded by a concrete wall 4 ft. high and 46 ft. in diameter, grading back from the top of which is an earth embankment 4 ft. higher. In case of fire or tank rupture this provides a pond, or retaining space, of twice the capacity of the tanks.

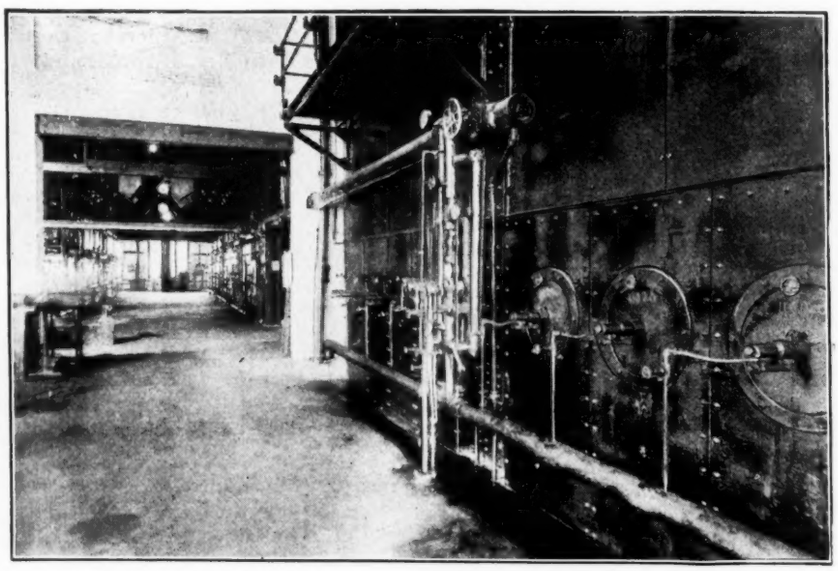


FIG. 1. BOILER ROOM OF FALL RIVER ELECTRIC LIGHT COMPANY

These tanks are filled by means of a 10-in. underground pipe line direct from the oil company's 55,000-bbl. supply tank. As a protection in case anything happens to the supply tank, a bypass connection between the filling line to this tank and one of the pump suction lines, makes it possible either to fill the service tanks or to feed direct to the pumps. With the duplication of the installation up to the main oil feed line it is the practice to consider one of each of the tanks, pumps and heaters as one unit and make use of the crossover connections only when necessary.

Directly outside the service tanks the suction lines are joined by a tie-line and inside the boiler room by a header, so that it is possible to use either pump on either of the tanks, as desired. From the header four 5-in. branches are taken off, two to each pump. These branches, with a strainer in each one, are of ample size to supply oil for the entire system, and by valve arrangement it is possible to clean strainers, one at a time, while the pump is running.

On the discharge side of the pumps there is another tie-line between the 4-in. lines to the heaters. This permits either pump to supply the system through either heater. Leaving the heaters, each line is again divided to allow strainers to be installed and then end in a header from which two lines are fed into the main oil feed ring, by either of two lines for the main boiler room and a single line to the battery in the boiler room extension. Blanked fittings have been left in the header for meter connections if ever deemed advisable. At the present time all oil measurements are made at the service tanks. Each tank is equipped with a ball float connected by chain to a pointer moving over a graduated scale on the side of the tank. These readings are taken once a day, also just before and after filling the tanks. Using these figures with a table of capacities computed for each one-eighth inch of the tank height and making temperature corrections is a very simple problem. That the computed figures for oil purchased have checked with the amount as billed by less than 1 per cent attests to the accuracy of the measuring device.

The pumps and heaters are set up on a cast-iron sole plate, extending out under the strainers and valves. This plate not only forms a foundation for the units, but with a 4-in. flange around the edge and drain connections to the sump tank, takes care of the oil that overflows when cleaning strainers or working on the pumps.

Referring again to Fig. 2, from the tie-line between the suction lines leaving the tanks, a line is carried to a small sump in the bottom of each tank. On the crossover between the sump discharge lines connections are made to the sump tank in the basement. These connections provide a means of pumping the tanks practically dry. After pumping a tank down as low as possible through the main suction line, the sump line is opened and the main line closed. The other pumping unit now

supplies the system while the first one pumps into the basement sump tank. This oil is allowed to settle and the sediment and sludge remaining in the tank is taken outside and burned, as it is prohibited by state law to throw it to waste. Fortunately, the tanks very seldom require cleaning.

The Fire Underwriters require the suction lines to be, at all points, one foot above the maximum possible elevation of the oil in the tanks, and also require the locating of the tanks 150 ft. from the boiler room. These requiremnts put quite a suction lift on the pumps and necessitate overhead piping. The suction lines are carried on arms extending out from pipe columns.

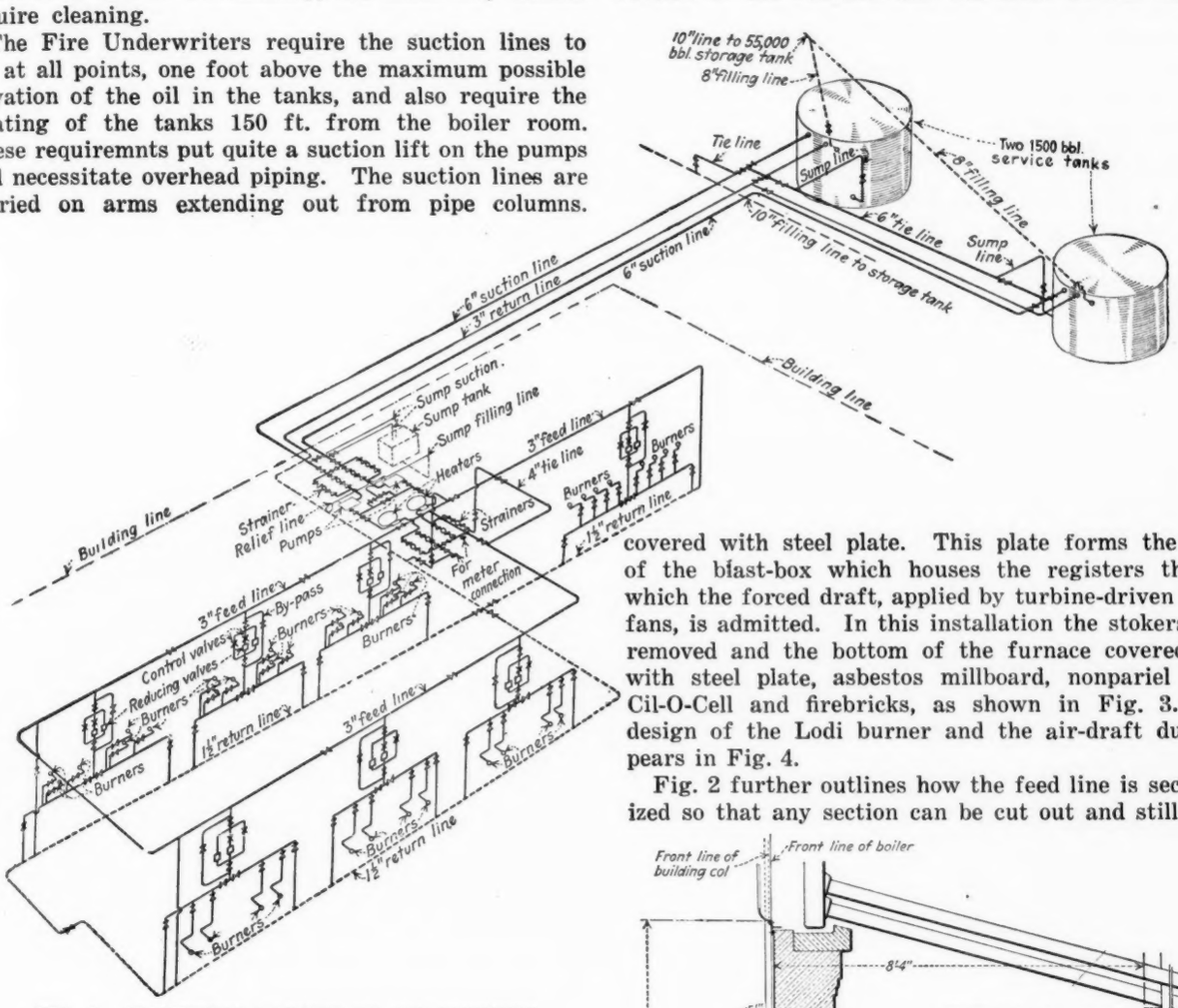


FIG. 2. ISOMETRIC LAYOUT OF OIL-BURNING INSTALLATION

Under each suction line is a 2½-in. exhaust steam line for heating. The exhaust steam from the oil pumps is used for this purpose with provision made to introduce additional exhaust steam when needed. These steam lines end in a heating coil inside each tank. The coil is made of six turns of 2-in. pipe, 8 ft. in diameter, exhausting to the atmosphere. It is located so that the suction line is in the center of the coil and the lower turn of the coil is at the same elevation as the bottom of the foot valve on the suction line. This heating system keeps the oil in the tanks at about 90 deg. F. It is carried to the heater at this temperature, or a little higher, where it is increased to an average of 240 degrees.

On top of the same crossarm supports are carried two 2-in. high-pressure steam lines for smothering in case of fire. These end in perforated pipes across the top of the tanks under the roof. The only valves on these lines are inside the boiler room.

The oil return line from the system is carried back to the tanks on the side of the pipe columns. It is divided, with one branch going to each tank. This is done in order that the returns may be put back in the tank from which the pump is taking its suction in order to keep the records of "Oil Used" accurate.

Fig. 1, a general view of the boiler room, shows the outside of the burners and the front of the furnace covered with steel plate. This plate forms the front of the blast-box which houses the registers through which the forced draft, applied by turbine-driven Green fans, is admitted. In this installation the stokers were removed and the bottom of the furnace covered over with steel plate, asbestos millboard, nonpariel block, Cil-O-Cell and firebricks, as shown in Fig. 3. The design of the Lodi burner and the air-draft duct appears in Fig. 4.

Fig. 2 further outlines how the feed line is sectionalized so that any section can be cut out and still main-

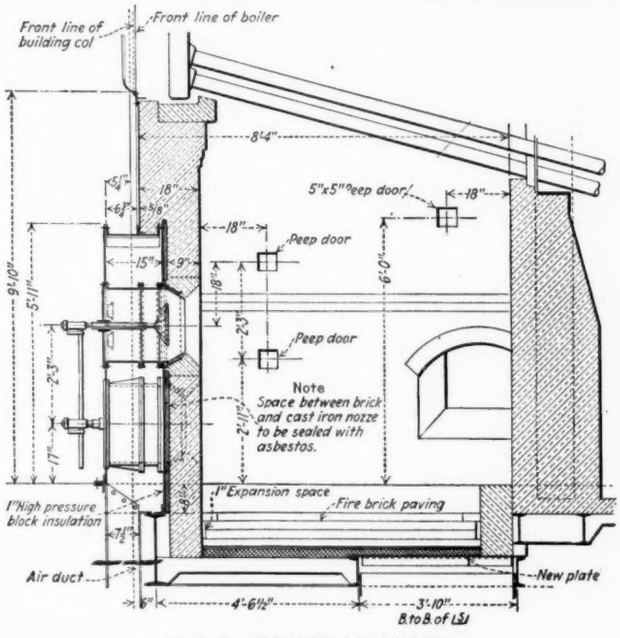


FIG. 3. BOILER FURNACE

tain service to the remaining batteries. In the center of each battery a branch is taken off the main oil-feed line, split in three lines of equal size, in which are placed valves used in connection with the automatic control system. This burner unit is bypassed so that it is possible to feed oil to the burners by hand control.

The main feed line is tied to the return line, connections being made to allow the circulation of hot oil through any part of the system that has been cut out and become cold.

From the discharge side of pumps to the return line the entire system is controlled by the Merit automatic control system described in *Power*—in this case being adapted to the mechanical type of burners. It is only briefly considered here as a full description was given in *Power*, Oct. 4, 1921.

Near the feed pumps is a steam-actuated master controller set, connected to the main steam header. This set operates a damper interlocking device on the front of each battery of boilers, which controls the stack dampers and by connections to the cutout valves, the fires in three predetermined steps.

The first step, for low fire, admits oil through the reducing valve on the right-hand branch of the burner unit at 100 lb. pressure; the second, or intermediate, fire, through the cutoff and reducing valve in the middle branch at 140 lb. pressure; and the third, or maximum, fire, through the cutoff valve in the left-hand branch at full pump pressure, or 160 lb. These three steps give boiler ratings from 50 per cent up to from 210 to 250 per cent with boilers having from 3,500 to 5,000 sq.ft. of heating surface and with three to four burners.

When load demands require, it is possible to increase the range from low to maximum fire and obtain higher ratings. In the operation of this installation it has not been found necessary to change the sprayer plates to vary the rate of evaporation and very seldom is it necessary to cut out single burners. As the load

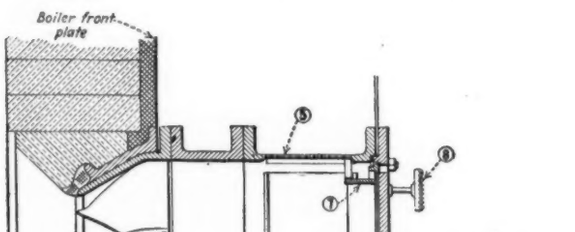


FIG. 4. LODI MECHANICAL OIL BURNING

changes, it is taken care of by change of fires until such time as it is necessary to cut out or in a boiler.

In addition to the damper interlocking devices the master controller set controls an interlocking device for fan control, being connected to butterfly valves on the steam line to the fan turbines.

The steam chart shows how well the pressure is controlled with very moderate variations under rapidly increasing and decreasing load conditions in the morning, at noontime and late afternoon. Load conditions for this day were as follows: 7 a.m., 1,000 kw.; 8 a.m., 10,600 kw.; 12 m., 10,300 kw.; 12:30 p.m., 3,000 kw.; 1 p.m., 10,600 kw.; 4 p.m., 10,800 kw.; 5 p.m., 8,800 kw.; 6 p.m., 3,700 kw.

The flue-gas analysis remains practically the same over the entire range of fires. Theoretically, there may be a slight drop in CO_2 when changing from one fire to another. However, it is of such short duration that an Orsat apparatus cannot determine it, and is

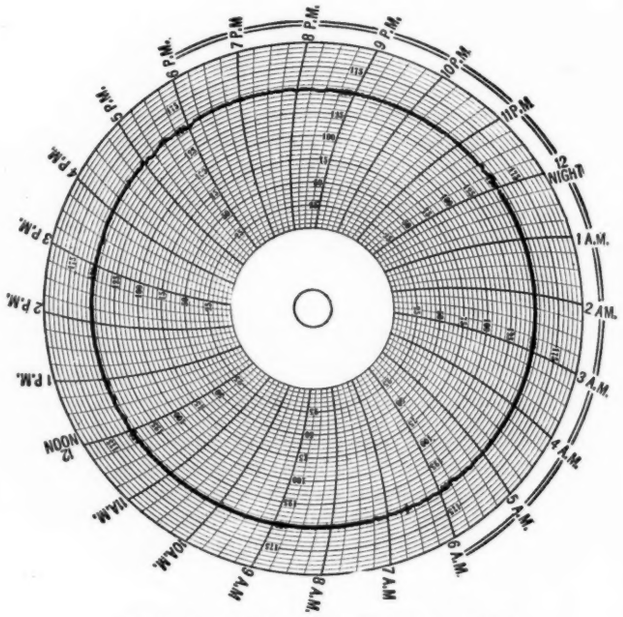


FIG. 5. DAILY PRESSURE CHART

due to the fact that the dampers are opened and fans speeded up an instant in advance of an increasing fire and remain this way for the same interval of time after the fires have stepped back. This is really a safety feature which assures a proper position of the dampers and correct forced-draft speed before changing fire. The operation of the entire oil-burning system has been satisfactory and flexible. After once being set, the automatic control carries the plant through all the load changes.

The use of oil as fuel has permitted a marked reduction in boiler-room labor. The plant is now operated with eleven less men than when burning coal. There were yard men, whose time was occupied in unloading coal and handling ashes, all of which labor is eliminated with oil burning. In these days of high labor costs the item of plant labor had become alarmingly high, and without doubt one of the chief advantages of oil fuel is the opportunity afforded to eliminate much of this labor charge. In addition the cost of maintenance of stokers as well as that of the coal- and ash-handling equipment when burning coal was far more than the extra cost of furnace maintenance occasioned by the oil.

Due to the reduction in furnace losses, such as banking fires, etc., together with the increased efficiency with oil as compared to coal, the over-all boiler room efficiency has been increased eight per cent.

Oil as fuel in this particular plant is unusually advantageous since the oil company's storage tanks are close by. The nearness of the fuel supply eliminates the danger of shortage so often experienced in coal-burning plants, especially during the winter months.

Switchboard-Meter Connections—Common Types of Alternating-Current Instruments

Wiring for Frequency Meters, Power- and Reactive-Factor Meters and Synchroscopes on Single- and Three-Phase Circuits

BY E. A. REINMAN

IN ALTERNATING-CURRENT distribution it is important that the frequency of the current reversals be accurately known, and for this purpose it is customary to install a "frequency meter." This instrument indicates in "cycles per second" or "alternations per minute." There are several types available. One is self-contained—that is, it has no external resistors or reactors—and is connected to the circuit just like a voltmeter, either directly if the voltage of the circuit and the instrument correspond, or through a potential transformer. The polarity need not be considered, as the instrument operates correctly regardless of the direction of power flow.

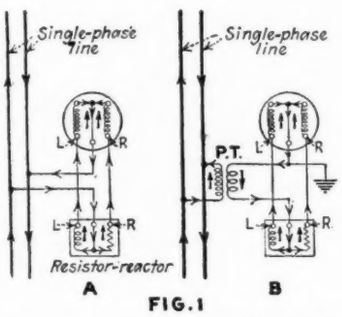


FIG. 1. SINGLE-PHASE FREQUENCY-METER CONNECTIONS

With external resistor-reactor. A—without transformer. B—with transformer.

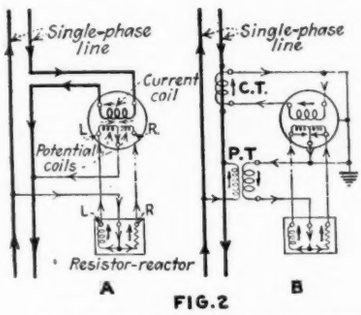


FIG. 2. SINGLE-PHASE POWER- OR REACTIVE-FACTOR METER WIRING

With external resistor-reactor. A—without instrument transformers. B—with transformers.

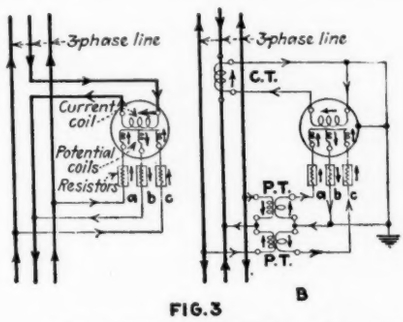


FIG. 3. THREE-PHASE POWER- OR REACTIVE-FACTOR METER WIRING

On balanced three-phase three-wire circuit. A—without transformers. B—with transformers.

In another type the instrument must be used in conjunction with an external resistor-reactor box. This box contains a reactance coil and a resistor and has three terminals. The instrument also has three terminals, and the two must be connected together as shown in Fig. 1A without transformers, and 1B with transformers. It is quite essential to get the two leads between meter and box correctly connected. The two terminals marked *L* should be connected together, likewise the two marked *R*. A crossing of these leads will make the instrument indicate a high frequency when the true frequency is low, and vice versa. An open circuit in either lead will cause the instrument to indicate to the extreme right or left side of the scale. Another point to watch is that resistor-reactors and instruments bearing the same serial number are used together, as they have been calibrated together and many cases of incorrect registration have been caused by the use of the wrong external resistor-reactor box. When used with potential transformers, it is customary to ground thoroughly one of the secondaries as well as the instrument case. Frequency meters consume but little energy for their operation and are frequently connected to the same transformer that supplies the other instruments. If two sets of transformers are used, one for metering and one for protective devices, the frequency meter should be connected to the protective set, as its indications are not affected by normal variations in voltage and the current it consumes might introduce inaccuracies in the more important instruments. Two other important quantities in an alternating-current circuit are the power factor and the reactive factor, the former being numerically equal to the cosine of the angle of phase difference between the current and voltage

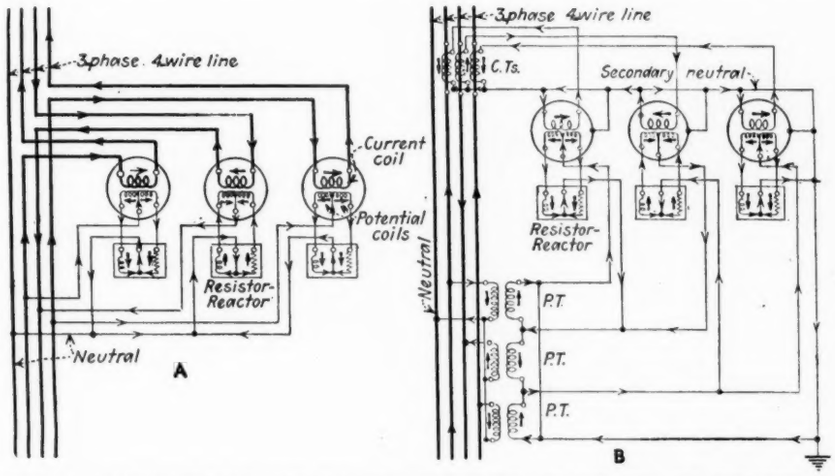


FIG. 4. CONNECTIONS FOR THREE SINGLE-PHASE POWER- OR REACTIVE-FACTOR METERS ON THREE-PHASE FOUR-WIRE CIRCUITS

A—Without instrument transformers. B—with current and potential transformer. Note that the potential transformers must be connected star-primary and delta secondary for correct phase relation between primary and secondary.

and the latter being the sine of this angle. Power-factor and reactive-factor meters merely measure this angle by the mechanical indication of a pointer, while the scale is actually marked with the sine or cosine of this angle.

The single-phase instrument may be connected to the circuit directly, as in Fig. 2A, or with both current and potential transformers, as in Fig. 2B. A resistor-reactor similar to that of the frequency meter is used with this instrument, usually in the form of an external box. The instrument has five terminals, two of which are for the series or current coil, while of the other three one goes to the line and two to the box. It is important to get the *L* and *R* connections correct, otherwise the meter will indicate "lead" instead of "lag" and vice versa. An open circuit in either *L* or *R* will cause the pointer to indicate continuously at either 100 per cent or 0 per cent regardless of the actual power-factor. There have been cases where the operator thought his power factor was high owing to an open circuit in the leads, when actually the power factor was about 60 or 70 per cent. A quick test is to shunt the current terminals with a piece of metal, such as a penknife or screwdriver; this will change the reading fifteen or twenty degrees if connections are all right. Otherwise it will have no effect. When making this test, care should be taken not to make a mistake and short-circuit the potential coils. One well-known type of meter includes the phase splitter in the instrument case.

An external resistor should be used in series with the meter for voltages from 200 to 500 volts, but the meter must be calibrated with the resistor. It cannot be calibrated on 110 volts and then a resistor added to make it good for 220 volts, for the resistor changes the relation of the currents between the phase splitter and the current circuit.

On a two-phase circuit it is customary to use either one or two single-phase meters with connections, as previously described. At one time many two-phase instruments were used, but these are seldom seen on present-day boards.

For a three-phase balanced circuit the correct instrument to use is a three-phase meter having one current and three potential coils. The connections are shown in Fig. 3. It will be noticed that there is a resistor in each potential winding and no reactor.

While these connections appear quite simple, yet, owing to the complexities of modern switchboards and phase relations, there are several connections that give incorrect registration. The first factor to be verified is phase rotation. A simple inspection is not sufficient to determine if the phase rotation is *abc* or *cba*. After connecting the meter, remove the series connection and then note which way the pointer tends to rotate (potential only applied). If it tends to rotate counter-clockwise, the connections are correct, but if it tends to rotate clock-wise, then lines *a* and *c* must be interchanged. A failure to do this will cause the instrument to read "lag" instead of "lead" and vice versa. Upon completing the series connection, it may be found that at 100 per cent line power factor the pointer indicates 60, 120 or 180 deg. from its correct position. If 180 deg., simply reverse the series leads. If 120 deg., shift the connections on the line side of the resistor as follows: Remove lead *a;* move *b* to *a*, *c* to *b* and *a* to *c*. If still 120 deg. out, but on the other side, shift them once again. If the pointer indicates 60 deg. off, then shift the leads once or twice as necessary and also reverse the series leads. The meter should now indicate correctly. It will be noted that the three-phase instrument is recommended only for a balanced three-phase circuit; if the phases are unbalanced, it will indicate only the power factor of the phase to which the current coil is connected. A serious unbalancing of voltages will cause a worthless indication.

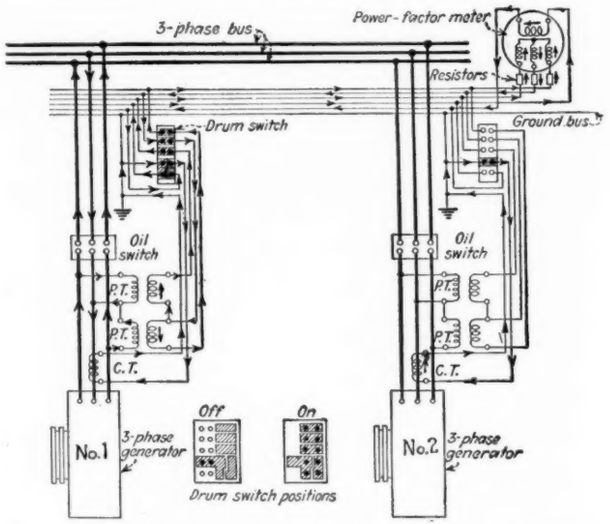
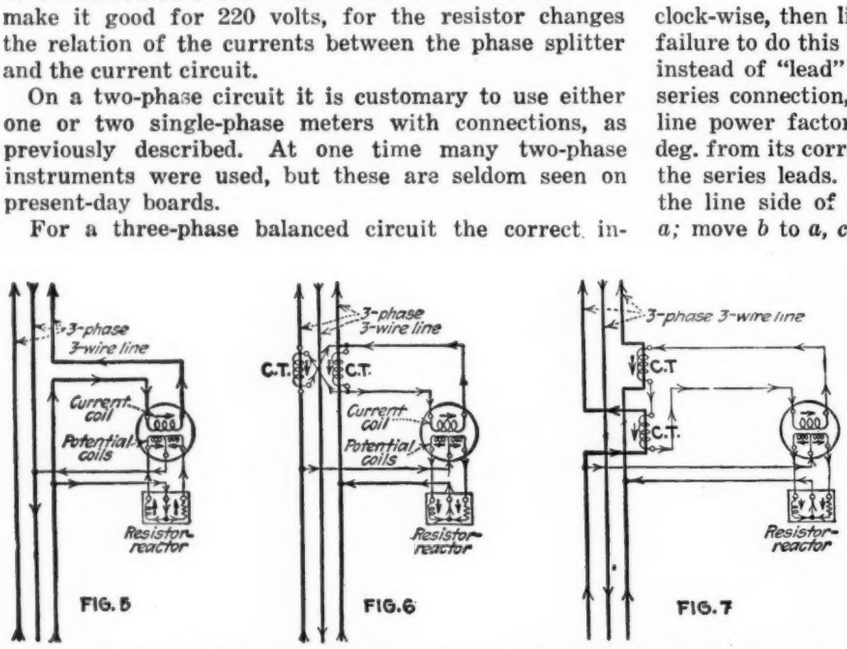


FIG. 8. THREE-PHASE POWER- OR REACTIVE-FACTOR-METER CONNECTIONS, USING DRUM SWITCH FOR CONNECTING METER TO DIFFERENT CIRCUITS
Meter connected to machine No. 1.



FIGS. 5 TO 7. SPECIAL CONNECTIONS FOR SINGLE-PHASE POWER- OR REACTIVE-FACTOR METERS ON THREE-PHASE THREE-WIRE CIRCUITS

Fig. 5—Single-phase meter direct-connected to one phase of three-phase circuit. Fig. 6—Single-phase meter connected through two cross-connected current transformers. Fig. 7—Single-phase meter connected to three-wire current transformer.

For three-phase four-wire or unbalanced three-phase circuits, three single-phase meters are used, with the connections of the potential coils as in Fig. 4A without and Fig. 4B with potential transformers. The star potential connection for three-phase three-wire is not always satisfactory, unless the potential coils of the three meters have the same impedance, or unless a Y-box of sufficient capacity be used to prevent a shifting of the neutral. When voltage transformers are used, they should be connected star primary and delta secondary. This

brings the voltage into phase with its current in each instrument at 100 per cent line power factor.

Another method widely used is the calibration of a single-phase meter connected to a three-phase circuit, as shown in Fig 5, so that it indicates the power or reactive factor of one phase. In this instrument the pointer is set 30 deg. ahead of its normal position so that when it is connected to the three-phase circuit, as in Fig. 5, its indications are correct. In other words, it indicates 100 per cent power factor or 0 per cent reactive factor when there is a phase difference of 30 deg. between current and voltage. A few engineers prefer to use a three-wire current transformer, connected as in Fig. 7, or two current transformers with the cross-connection as in Fig. 6. These result in the current and voltage being in phase at 100 per cent line power factor, but require a balanced load to give a correct registration.

On switchboards where there are many feeders running to various sections of the plant, it is not usual to have a power- or reactive-factor meter for each feeder. Instead, each feeder is equipped with a drum switch and the whole set equipped with only one handle, which can be removed only when the switch is in the off position. As will be seen from the diagram of connections in Fig. 8, this enables both the current and potential coils of the meter to be thrown from one feeder to the other. In fact, the connections are so isolated when the switch is open that the meter may be arranged to indicate the power factors or reactive factors of feeders or systems fed by entirely different machines. Several other types of switches may be used for this purpose.

Although the synchroscope indicates phase relations exactly as in the power- and reactive-factor meters, its applications and connections are entirely different. The synchroscope has two voltage windings and of late years is made almost exclusively in a single-phase instrument, because if one phase is in synchronism, the others must be if connected correctly.

It utilizes a resistor-reactor box like the power-factor meter for splitting the phase, but may be made self-contained with the reactor-resistor included in the case. For a simple circuit, where one machine must be synchronized to a bus, the connections take the form of Fig. 9, in which it will be readily noted that the incoming machine connects to the top terminals and the bus connects to the lower terminals. The bus voltage is assumed low enough to connect direct to the instrument. The *L* and *R* connections to the external box must again be carefully made, as their reversal causes the indicator to read "Fast" instead of "Slow" and vice versa. An open circuit in the *L* or *R* connections may cause the indicator to assume the correct point of synchronism although the machines be widely out of step. As this would lead to disastrous results should the switch be closed, it is customary to connect lamps around the synchroscope as a check on the correctness of its indications.

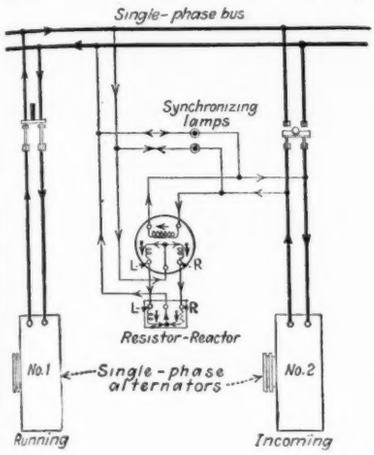


FIG. 9

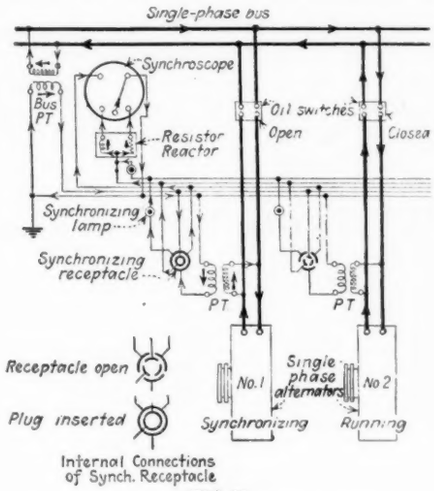


FIG. 10

FIGS. 9 AND 10. SYNCHROSCOPE CONNECTIONS FOR SYNCHRONIZING TWO SINGLE-PHASE GENERATORS.

Fig. 9—Simple connections for synchroscope and synchronizing lamps. Machine No. 2, incoming, to be synchronized with machine No. 1, running. Fig. 10—Switchboard wiring for synchroscope, using plug-and-receptacle type synchronizing switch. Note that one plug only is necessary, that the incoming machine, No. 1, is synchronized directly with the bus, and that a bus potential transformer is needed.

Present practice often decrees the use of several parallel generators, and as the use of several synchroscopes is superfluous, most boards are equipped with synchronizing receptacles and connections similar to those in Figs. 10, 11 and 12. The plan illustrated in Fig. 10 provides a receptacle for each machine and one plug for the whole board, thus making it impossible to attempt the synchronizing of more than one machine at once with a consequent short-circuit between incoming machines. It is to be noted that with this arrangement the incoming machine is synchronized directly with the bus, through the medium of a bus potential transformer. Fig. 11 shows another arrangement whereby the incoming machine is synchronized

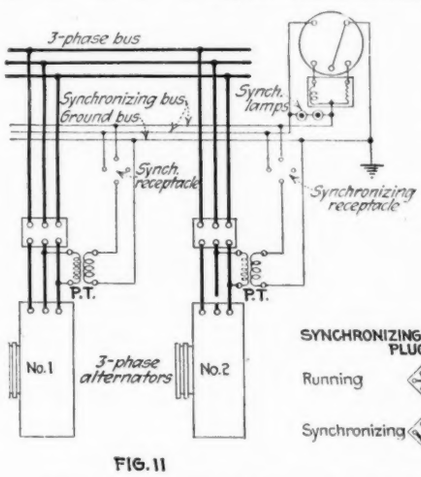


FIG. 11

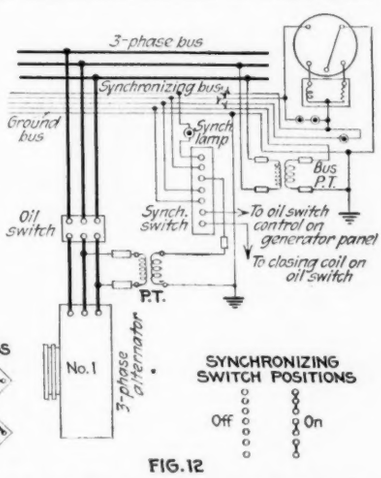


FIG. 12

FIGS. 11 AND 12. SWITCHBOARD CONNECTIONS FOR SYNCHROSCOPE USING SYNCHRONIZING SWITCHES

Fig. 11—Synchroscope wiring using another type of plug-and-receptacle synchronizing switch. Note that the incoming machine is synchronized with any other running machine, that two separate plugs are required, but no bus potential transformer. Fig. 12—Synchroscope wiring using drum-type synchronizing switch. Note that the incoming machine is synchronized directly with the bus; a bus potential transformer is required.

with any machine already running—therefore already connected to the bus. Two plugs are required, one for the running machine and one for the incoming machine, but the bus transformer may be dispensed with.

When the plugs are withdrawn, the instrument is completely disconnected, thus preventing heating of the instrument and waste of energy. Lamps are also used as a check on the indications and its connections.

A synchronizing switch of the drum type may also be used. One switch is provided for each machine, while only one handle is provided for the entire board, and the handle can be removed only when the switch is in the off position. Fig. 12 gives the connections for this type of switch, only one generator being shown. In this case the incoming machine is synchronized with the bus. An important feature of this switch is the interlocking of the control of electrically operated breakers with the synchronizing switch. Thus if the synchronizing switch is open, it is impossible to close the oil switch that connects the incoming machine to the bus. As soon as the synchronizing switch is closed, however, the main switch may be closed even though the machines are not in synchronism. This point can be made foolproof only by an automatic synchronizer.

Pulverized-Material Conveyor System

THE economic advantages of pulverized coal as a fuel for boilers, metallurgical and industrial furnaces, where the ash can be disposed of effectively, is recognized. The application of this fuel in its broadest field has been hampered because in most cases the fuel-consuming units are not segregated, and an installation would necessitate the use of unwieldly conveying systems. The expense, together with the unreliability in operation of these systems, usually discounted the advantages to be derived by substituting pulverized coal for other fuels in plants of this nature.

The most accepted method of transporting pulverized fuel has been by a combination screw or belt conveyor with bucket elevators. However, installations have been made using low-pressure large-volume air or high-pressure low-volume air, although in most cases the mechanical method predominated. These systems presented rather a limited field from which to choose, as each had certain inherent disadvantages.

However, there has been developed a method known as the Fuller-Kinyon conveying system for pulverized materials which combines the positive features of the mechanical and air conveying systems and eliminates the objectionable points found in each. This system combines the mechanical action of a screw with the fluidizing properties of air to impart motion to the pulverized material. As shown in Fig. 1 the main elements in the arrangement comprise a power-driven pump, the function of which is to start the mass in motion; source of compressed-air supply and a pipe through which the material flows.

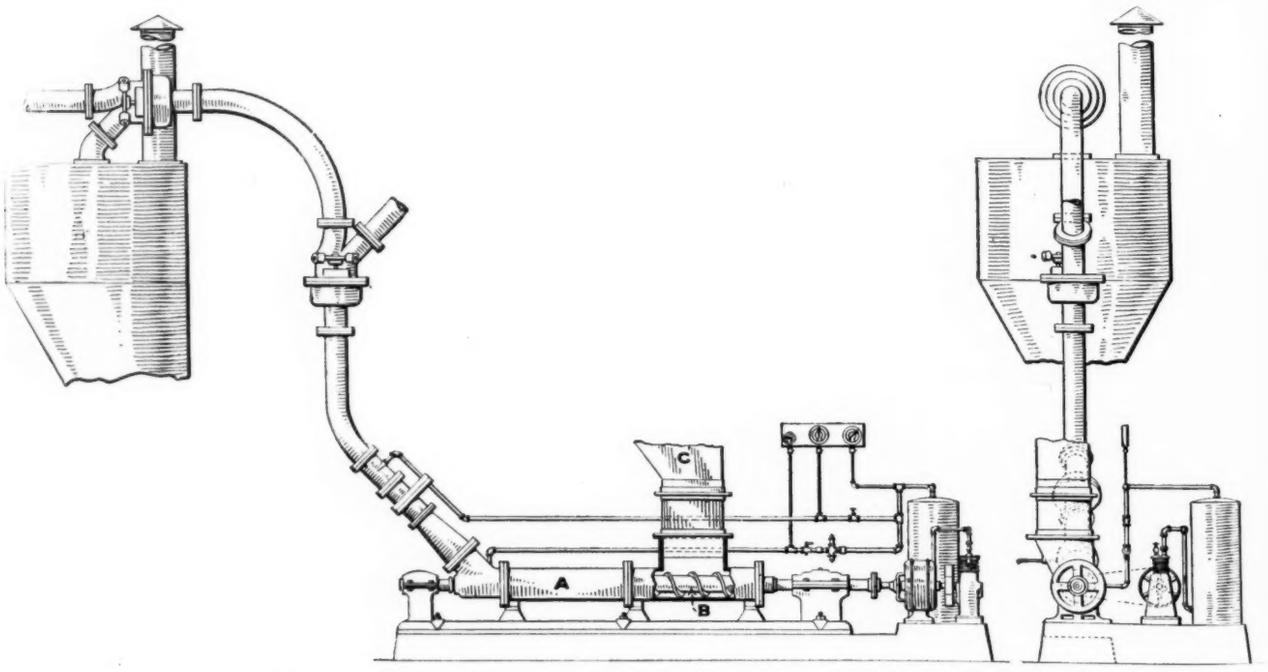


FIG. 1. SHOWING THE PULVERIZED-MATERIAL CONVEYOR SYSTEM

The pump *A*, Fig. 1, consists essentially of a specially designed worm or screw *B*, revolving in a closed chamber or working barrel. The screw is mounted on an extension shaft that passes through packing boxes located in each end of the casing and is supported by outboard bearings. This arrangement prevents the pulverized material from coming into contact with the bearing metal, thus preventing undue friction and damaged bearings.

Pulverized material is fed from its source into the pump hopper *C*, and is carried by the screw through the barrel to the discharge end. Here the mass is aërated by a number of small-volume streams of compressed air

at moderate pressure, and this changes the nature of the material from a compact mass to a semi-fluid, in which state it is carried to the point of discharge.

The conveying line is usually built of ordinary wrought-iron or black-steel pipe, the diameter depending on the capacities of material desired, the predominating sizes varying between 3 and 5 in. in diameter. This pipe line can be located in the most convenient place between the pump and the service bins.

In cold climates no provision need be made to cover the pipes to prevent freezing. The pulverized material is practically dry when delivered to the pump, and the amount of air used for aëration is so small that even if saturated, the moisture contained is not sufficient to create a freezing condition.

The distributing valves, Figs. 2 and 3, which are located in the pipe line, are of the disc-multiple discharge-port type, so arranged that the stream of material may be diverted from the main line to any one of two or more branch lines leading to various receiving bins.

The valve consists of two sections that form a cylindrical housing, the interior constituting a valve chamber. The single tubular arm on the intake end is connected to the main line, and the opposite divergent arms

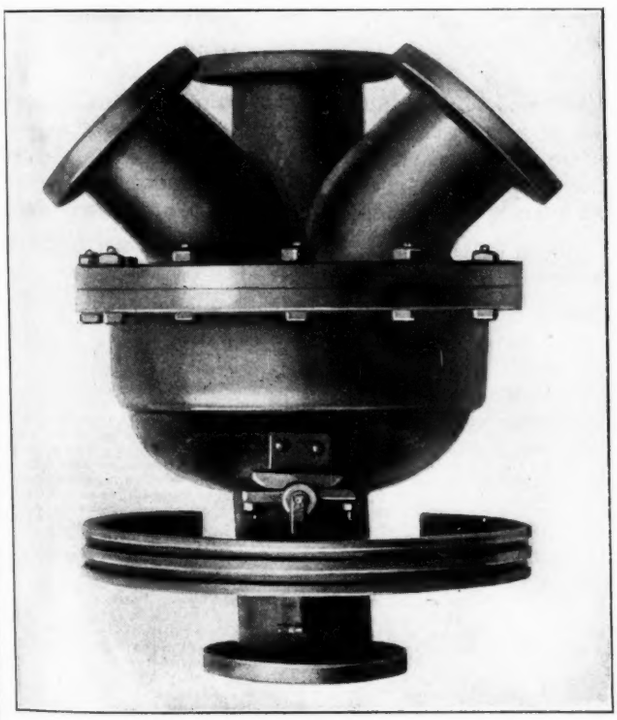


FIG. 2. PULVERIZED-FUEL DIVERTING VALVE

are coupled to an extension of the main line of pipe and to branch lines.

The valve disc is circular in form and exceeds the diameter of the ports. It is pivotally carried on the end of an arm disposed at right angles to the axis of the disc, this arm being supported by a shaft, rotatably mounted in the casing and carrying on its outer end an operating wheel by means of which the disc is rotated between its operative positions. There is sufficient lateral play of the disc to permit it to accommodate itself to the seat upon which it is to rest. The disc has a flat face, the peripheral edges of which are sharply beveled and cut or scrape adhering particles of coal from the surface over which it travels.

To provide means whereby the interior of the housing may be kept practically free from particles of pulverized coal that might otherwise collect therein and prevent the free movement of the disc, and also whereby the flow of pulverized coal is facilitated or boosted, a rela-

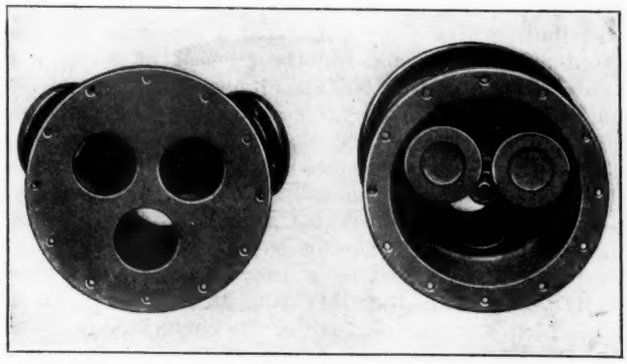


FIG. 3. INTERIOR VIEW OF DIVERTING VALVE

tively small air pipe may be located to direct a jet of air under pressure into the valve chamber in the general direction of the flow of the material. This type of valve is complete with two or more arms on the discharge end.

A pulverized-material bin indicator, Fig. 4, used in connection with this system, makes its operation practically automatic and foolproof. The indicator consists of a cylindrical casting equipped with two diaphragms. One indicator is installed near the top of the bin and one near the bottom, and the action of the coal against these diaphragms either makes or breaks an electrical contact inside of the indicator, which in turn operates lamps or bells, thus advising the operator that the bin is full or empty, and eliminating all possibility of overflow or running short of coal. In recent pulverized-coal installations this system has been carried even further from a safety viewpoint. It is so arranged that the pump in the coal-house can be stopped by the bin tender at the furnace. The amount of air used to fluidize the coal is so small that combustion cannot be supported in the line, and an explosive mixture is not approached. This small amount of air used also eliminates the necessity of discharging into an air separator at the end of the conveyor line.

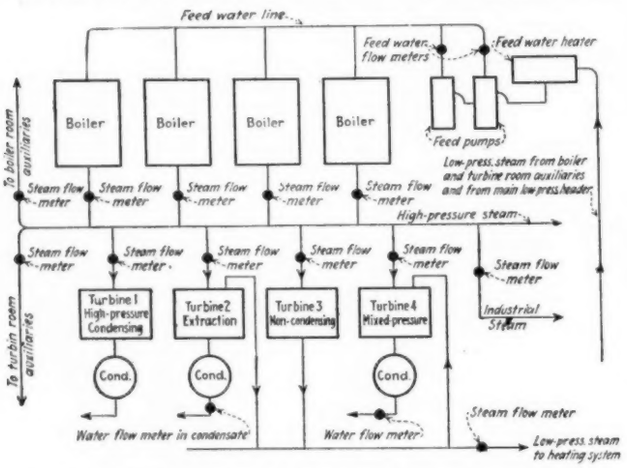
FIG. 4. PULVERIZED-MATERIAL BIN INDICATOR

About twenty-five years ago occurred the first use of fuel oil in considerable amount. At that time the discovery and subsequent over-production of the Los Angeles oil field reduced prices to the point where practically all Californian industries began to adopt oil.

Accounting for Steam Production and Distribution

By A. R. SMITH
Construction Engineering Department, General Electric Company

IT IS ESSENTIAL to the proper conduct of any business, whether it be the production, sale or distribution of a commodity, that a statement be prepared at set intervals, for the purpose of striking a balance between debit and credit accounts. Any well-managed industry will, at least once a year, account for the quantity of articles disposed of and inventoried against the quantity produced. In many instances the difficulty of obtaining such data on commodities, because of the time required for production and the wide distribution of parts throughout a factory, precludes the possibility of showing a balance for shorter than yearly periods. On the other hand, if the time required to complete the manufacture of the commodity is relatively short, valuable records can readily be maintained to show the detail costs, the waste and the possible improvements in operating facilities or methods of production.



FLOW-METER INSTALLATION TO GIVE DATA FOR BALANCE SHEET

The operation of a steam-electric power plant or a steam-heating plant is not essentially different from that of other manufacturing plants. It produces steam or electric power, or both. While these products, the production of which is completed in minutes instead of days or months, may appear less tangible than ordinary commodities, they can be readily measured. In this case production is immediately followed by consumption and there is, therefore, no stockpile to be inventoried at intervals. This short period of production and disposition naturally makes improvements in operating methods more conducive to economies than when the commodity requires a longer time to manufacture and consume.

Steam-Power Plant Products

The products of a steam-electric power plant are steam and electricity. Often only a portion of the steam produced by the boilers is converted into electric energy, the remainder being utilized for heating and other industrial purposes. The only practical method by which to record performances for such a plant is to meter each product and to consider the boiler room as the steam producer and the turbine room the power producer. The turbine room as well as the heating system then purchases a certain amount of steam from the boiler room. This method of analysis is equally essential to the plant whose steam is all converted into electric energy, since in any instance the economy of steam production should be carefully checked. Such a record cannot so easily be maintained when the production costs are all charged directly to electric power without regard to the quantity of steam generated or consumed.

With the commercial introduction of electricity, electric energy has been measured in every conceivable manner and no concern would consider its production or distribution without a thorough accounting; in fact, meter records are kept showing the energy consumption on the smallest feeder circuits. The metering of steam, water and air, on the other hand, has heretofore been neglected largely because satisfactory meters for the purpose have been available only within the last few years.

Units of Measurement

All commodities, tangible and intangible, are susceptible of measurement, although in some cases a concise inventory or accounting is rather expensive to obtain. Most commodities are measured, or counted, by units which are readily understood because of commonplace and long-continued usage. The accepted units of measurement for heat and power are as definite and simple as the common units used in every-day practice. The chief difference is that the former cannot be visualized and are, therefore, often discredited by those not familiar with engineering terms. The unit of measure-

UNITS COMMONLY USED IN POWER-PLANT PRACTICE

Kilowatt-hour:	Unit of electric energy or work. The product of power and time (in hours). Kilowatt-hours = kilowatts × hours.
Kilowatt:	Unit for measuring electric power; that is, the rate of production or consumption of electrical energy. $\text{Kilowatts} = \frac{\text{Kilowatt-hours}}{\text{Hours}}$
Pounds of water per hour:	Unit of water demand. Employed in measuring the rate at which water is fed to boilers.
Pounds of steam per hour:	Unit of steam demand. This unit shows the rate at which steam is produced or consumed. It does not represent a true value of power, because the actual heat required to produce a pound of steam varies with the pressure, superheat and sensible heat in the water. It may be advantageously used, however, for small plants because it simplifies calculations: but for larger plants the heat consumption should be expressed as equivalent pounds of steam from and at 212 deg. F.
Note:	For convenience in accounting and preparing balance sheets, the units Pound of Water, Pounds of Water per Hour, Pound of Steam and Pounds of Steam per Hour are often expressed in "thousands," thereby eliminating the use of such large numbers.
B.t.u.:	Unit of heat commonly used in this country. The quantity of heat required to raise one pound of water 1 deg. F. at or near 39.1 deg. F., the maximum density of water.
Equivalent pounds of steam from and at 212 deg. F.:	Unit used for the reduction of steam measurements to a common basis. It represents the weight of water that could be evaporated from the temperature of 212 deg. F., into dry and saturated steam at 212 deg. F., by the actual amount of heat transferred to the feed water in the boiler. It is equal to the total heat in the steam under boiler conditions, minus the heat in the feed water, divided by 970.4, the latent heat of steam at 14.7 lb. absolute. For example, 1 pound of steam at 250 lb. abs. and 250 deg. of superheat, produced from feed water at 150 deg. F., is equivalent to 1.257 lb. of steam from and at 212, since 1,221 B.t.u. are added to each pound of feed water, and 1,221 divided by 970.4 equals 1.257.
Million B.t.u.:	Convenient unit for measuring large amounts of heat. One pound of steam at a temperature of 212 deg. F. and 14.7 absolute pressure contains 1,150.4 B.t.u. Therefore 869.2 lb. of saturated steam at that pressure contain about 1 million B.t.u.

ment for electric energy, the "kilowatt-hour," was for many years generally regarded as the least tangible and conceivable, but owing to the use of electric light and power in the home, it is now quite generally understood.

"Pound" or "thousand pounds" generally used for the measurement of steam should be no more difficult to understand as a unit than pounds of water, since steam is nothing more than water in the form of vapor.

Balance Sheet

The waste of heat in a power plant is far more common and extensive than the waste of electric power, since any loss in the latter may readily be detected. Furthermore, the possible economies in the production and utilization of steam greatly exceed the possible economies in the utilization of electric power, because the electrical conditions for any plant are more or less fixed when the apparatus is installed, but economy in the generation and consumption of steam is largely under the control of the operator.

Form A

POWER PLANT BALANCE SHEET

First Balance—Boiler Room	Thousand Pounds Steam per Month	
	Debit	Credit
1—Total water to boilers	100,000	
2—Blowdown from boilers		1,000
3—Steam to boiler-room auxiliaries		5,000
4—Condensation, waste and unaccounted for		1,000
5—Net steam available for utilization		93,000
6—Balance	100,000	100,000
Second Balance—Turbine Room		
7—Net steam available	93,000	
8—Converted into electric power		40,000
9—Used for heating		30,000
10—Used for industrial purposes		23,000
11—Balance	93,000	93,000

The proper method of maintaining dependable records is to show balances between the steam produced and the steam consumed. The first balance is between the amount of water supplied to the boilers and the quantity of steam the boilers produce. The second balance is between the steam produced by the boilers, available for utilization, and the steam used for the production of power or for heating and industrial purposes.

Form *A* illustrates a simple balance sheet for a small plant, while Form *B* illustrates a more complete one for larger plants. The diagram illustrates in a simple manner the locations of flow meters to obtain information for such a balance.

Description of Balance Sheet Form B

Lines Nos. 1, 2 and 3: There should be a line provided on the balance sheet form for each main turbine in the plant. The actual steam flow as metered should be filled in in column *A*, *B* or *C*, depending on the type of turbine; for example, if unit No. 1 were a straight high-pressure condensing turbine, the steam fed to it in thousand pounds would be recorded in column *A*. If it were a high-pressure non-condensing turbine discharging to a heating system, the total flow to the turbine would be recorded in column *B*. If a turbine were run both condensing and non-condensing, both column *A* and column *B* would be filled in according to the percentage of the power generated each way. Column *C* would be used for low or mixed-pressure turbines, and would show only the low-pressure steam which enters such turbine.

Line No. 4: Steam-driven turbine-room auxiliaries are treated similarly to the main units. These are generally non-condensing, and the exhaust steam is used to heat the feed water.

Lines Nos. 6 and 7: High-pressure steam for heating should be metered and recorded in column *A* since it is condensing steam, inasmuch as the return is water. Where the heating steam is low-pressure it may be metered and recorded in column *C* or it may be estimated from turbine water rates.

Lines Nos. 9 and 10: Industrial steam, if high- or low-pressure, is treated the same as heating steam.

Form B

POWER PLANT BALANCE SHEET

Steam Distribution	Column A	Column B	Column C	Column D	Column E	Column F
	Steam in Thousand Pounds as Recorded by Flow Meters			Equivalent Steam from and at 212° F.—Thousand Pounds		
	High-Press. Steam Condensing	High-Press. Steam Non-Condensing	Low Press. Steam Condensing	Total Debit	Credit for Exhaust Returned	Net Steam Chargeable to Each Service
1—Turbine No.						
2—Turbine No.						
3—Turbine No.						
4—Turbine-room aux.						
5—Electric power—total						
6—Heating—high press.						
7—Heating—low press.						
8—Heating steam—total						
9—Industrial steam						
10—Industrial steam						
11—Industrial steam—total						
12—Total—distribution						

Steam Production	Column G	Column H	Column I
	Water or Steam in Thousand Pounds	Eq. Steam from and at 212 Deg. F. in Thousand Pounds	
		Debit	Credit
13—Total water fed to boilers			
14—Estimated blow-down			
15—Net water converted to steam			
16—Boiler-room auxiliaries			
17—Used in feed-water heater, exclusive of steam from B. R. aux.			
18—Waste exhaust steam			
19—General condensation			
20—Unaccounted for			
21—Net distributed			
22—Balance			

* * * * * * * * * * * * *

CONDENSED RECORD OF POWER PLANT USING THIS FORM OF BALANCE SHEET. AN AVERAGE DAY'S RUN

Steam Distribution for Day	Pounds
1—To turbines (by flow meters)	2,000,000
2—Industrial steam (by flow meters)	950,000
3—Station auxiliaries (by flow meters)	110,000
4—Oil pumps, thawing coal, etc. (estimated)	20,000
5—Drips, traps, radiation, etc. (estimated)	20,000
6—Total	3,100,000

Steam Production for Day	Pounds Shift No. 1	Pounds Shift No. 2	Pounds Shift No. 3	Pound Total for Day
7—Water fed to boilers (by flow meters)	1,445,000	905,000	790,000	3,140,000
8—Blow-down	15,000	15,000	10,000	40,000
9—Net water converted to steam	1,430,000	890,000	780,000	3,100,000
10—Total steam from boilers (by flow meters)	1,430,000	890,000	780,000	3,100,000

Columns D, E and F: In column *D* the total debit should be given in thousand pounds from and at 212 deg. F., which is calculated from the total heat in the steam above the prevailing water temperature entering the feed-water heaters.

In column *E* a credit should be given to all machines operating non-condensing and furnishing exhaust steam which may be utilized for other purposes. If the exhaust from any non-condensing machine is too intermittent or is so contaminated with oil that it is inadvisable to utilize it, no credit should be given.

In column *F* the net steam chargeable to each unit or each service should be recorded. This column is simply the difference between columns *D* and *E*.

Lines Nos. 13, 14 and 15: The total water fed to the boilers and the steam output of each boiler should be metered. The amount of water blown down can be estimated from the time that the blow-down valves are open, if it is known how much the blow-down valves will pass per minute. If this is unknown, it can be easily determined by experimentation. The difference between the water fed to the boilers and the blow-down shows the net water which should have been converted into steam. This result should check the total steam output of the boilers very closely. The heat in terms of equivalent steam from and at 212 deg. contained in this water converted into steam should be shown in the credit column *I*. This is calculated from the total heat in the steam above the water temperature entering the heaters.

Line No. 16: The supply of all the auxiliaries in the boiler room can generally be recorded on one meter, although it is fairly accurate to include odd machines which may not be metered by calculating the steam flow from the prevailing loads and water rates. If all the steam passing through the boiler-room auxiliaries is used in heating the feed water, there is no need for segregating this credit. Simply charge the full amount of steam to the auxiliaries, as shown in the table.

Line No. 17: If the steam to the feed-water heater is not metered, as is generally the case, it should be estimated from the quantity of water fed to the boilers and the temperature elevation of the water.

Lines Nos. 18, 19, 20: Estimates should be made of the general condensation and the balance sheet should show any waste of exhaust steam. The unaccounted for steam will be the difference between the credit and debit column necessary to make a balance.

Line No. 21: The net steam distributed is taken from the first tabulation, line No. 12, column *F*. Plant records which do not show a satisfactory balance between the steam production and the steam consumption are not dependable, and the cause of the discrepancy should be carefully investigated.

Possible Losses

Many possible losses can be detected by the use of the balance sheet. For example:

First: Feed water is often heated to the maximum temperature and then overflowed because of inadequate storage capacity. The loss of heat from this cause is not readily detected unless all the steam is accounted for. Waste exhaust steam from the vent pipe of a feed-water heater is commonly considered a criterion of feed-water heater economies, but this is by no means true.

Second: Steam traps, drip and drain piping often blow steam continuously to a sewer, and there are no means of detecting it except by accounting for the steam generated and consumed.

Third: In some cases the use of steam far exceeds the expected consumption. As an illustration a certain plant introduced steam jets in the boiler furnaces and expected a very moderate steam flow. Actual records showed that the auxiliary steam consumption of the power plant was increased from 10 to 25 per cent. The steam jets were removed immediately.

Fourth: The steam-driven auxiliaries employed in power plants are frequently very inefficient, on account of either poor selection or improper maintenance. It is a mistake to use wasteful auxiliaries on the assumption that the heat in the exhaust steam is used in the feed water. High-pressure steam or extracted steam from the main units should be used to augment the deficient supply of steam for the feed water. There is then an opportunity of regulating the feed-water temperature or of reducing the waste for all conditions of load.

Fifth: Loss by radiation is a considerable factor and should be carefully estimated with a view to reducing it as much as possible by the application of proper lagging on pipes and machines.

Ways and Means of Metering

Each station presents special problems for the installation of flow meters, and it is therefore advisable to consider which type of flow meter and form of balance sheet is best situated for the existing conditions.

The common practice is to meter the high-pressure steam to each turbine. This is quite satisfactory for a straight non-condensing or condensing turbine, but in the case of a low-pressure, mixed-pressure or extraction turbine, the relative flows of low- and high-pressure steam can be more accurately determined by metering both the high pressure steam to the main unit and the condensate from the condenser. This recommendation applies to units employing surface condensers.

There is no objection to metering all the power-house auxiliaries as a unit, provided those used in the turbine room can be segregated from those used for steam production. A common method is to provide one flow meter for boiler-room auxiliaries and another for turbine-room auxiliaries.

The metering of boiler feed is generally accomplished by installing a flow meter on the discharge of each boiler-feed pump. In the case of reciprocating pumps, sufficient air-chamber space, together with pressure throttling between the pump and the point in the line where meter is connected, is necessary to obtain accurate readings.

Advantage of Metering Boiler Outputs

All the advantages accruing from the use of flow meters showing the output of each boiler are not generally recognized. In some plants the water fed to each boiler is metered, but the prevailing practice is to meter the steam generated by each boiler. Some of the advantages of getting a record of the individual boiler outputs are as follows:

First: Every boiler has a most efficient point in the operating curve, and this is generally from 100 to 175 per cent boiler rating. Assuming that the most efficient point of the boiler is known, in what way can an operator maintain the boiler at this capacity without a meter record?

Second: In order to check the regular over-all boiler and furnace efficiency, the results of which check are

far more valuable than special tests, the amount of steam produced by a boiler each month should be checked against the amount of coal consumed.

Third: Meter records will show the relative values of different kinds of boilers, stokers, methods of baffling, methods of firing, etc., both as to capacity and economy.

Fourth: It is common practice to compare the results obtained by the firemen on different shifts and to change the shifts from night to day so that each set of firemen will have an opportunity of working on the same load conditions.

Fifth: Individual boiler flow meters indicate if a fireman is doing his part of the work. There is a tendency for a man to sacrifice output for the sake of maintaining a good efficiency or a high CO_2 content in the gas.

Sixth: A record of what each boiler is capable of doing for the prevailing and for emergency conditions is especially valuable when trying to ascertain if additional boiler capacity is required. To illustrate this point, a certain company was contemplating the expenditure of several hundred thousand dollars for new boilers, until it was found that the existing boilers were operating at only 65 per cent of the rated capacity.

Seventh: In general, how can a fireman be expected to learn to operate a boiler and stoker to the best advantage without affording him a continuous record of the steam output?

This point is well covered by the following quotation from an editorial appearing in one of the engineering magazines:

> No one would expect the electrical end of a plant to be operated satisfactorily without some instruments to guide the operators. Yet the pressure gage and the water column have been and are about all the average boiler attendant has to help him. For the rest, he is supposed to be able to get along by using his eyes to judge the condition of the fire. There are some men naturally gifted who can do fairly well under even these circumstances, but why leave to human judgment a problem that is easily simplified until it is no trick at all by providing a few thermometers, a steam-flow meter on each boiler and a draft gage?
>
> There is nothing mysterious about burning coal so as to get the most heat out of it where and when it will do the most in turning water into steam, but it cannot be done continuously and consistently without the means mentioned to show the firemen when it has happened, and if it has not, why.

The maintenance of accurate records showing the steam generated and consumed as well as the water supplied to the boilers is essential for the economical management of central stations and manufacturing industries. Without such records, serious losses will probably be undetected. Follow the example of hundreds of companies both in this country and abroad. Eliminate guesswork, meter steam and water the same as electricity, use the form of balance sheet best suited to the particular plant and thereby save money in the cost of operation.

It is estimated by the Westinghouse Electric & Manufacturing Co. that it will do a $100,000,000 business in its fiscal year ending March 31, 1922, as compared with about $151,000,000 for the preceding year, indicating that present business is running about 67 per cent of last year's for that company.

Carrying Capacity and Contact Drop of Brushes

One of the first considerations in the selection of brushes is that they should have ample carrying capacity for the application in question. Carrying capacity is the current density in amperes per square inch of cross-section that a brush can carry under normal operating conditions on an average machine without injurious heating. Current density is calculated for a direct-current commutating machine by dividing the rated-current capacity of the machine by the cross-sectional area of half of the brushes. On slip-ring applications where all the brushes on one ring are in multiple, the current density is calculated by dividing the current flowing through that ring by the cross-sectional area of all brushes bearing on the ring.

There is no standard method of determining by test the carrying capacity for a given grade of brushes. It is influenced by all the factors tending to produce heat within the body of the brush or at the contact face. It will vary with the type of machine on which the brushes are applied. Brush manufacturers usually list the carrying capacity of their grades for operation on average direct-current designs. A separate rating is sometimes given for operation on slip rings. Since there will be no heating effect from short-circuit currents, when brushes are operating on slip rings, the carrying capacity will be from 20 to 50 per cent higher than that of the same grade under conditions of commutation. In the case of intermittent-duty commutator-type machines, such as crane and hoist motors, it is also permissible to allow current densities of 25 to 50 per cent over the rated carrying capacity. The operation of such machines is seldom continued over an extended period and there are frequent periods of idleness during which the temperature of machine and brushes may return to normal.

Another of the important characteristics to be considered in brush selection is the voltage drop across the contact between brush and rotating element when normal rated current density is flowing through the brush. This characteristic is spoken of as contact drop. It is listed in different ways by different manufacturers. Some show the average drop across one brush contact. Others show combined drop across the contact of both positive and negative brushes, while still others give no definite figures, but define contact drop in general terms such as very high, high, medium, low and very low. The reason for the latter course is that contact drop, like coefficient of friction, is influenced by a number of factors which are very difficult to control, and a standardized method of testing has never been developed. For this reason general terms in defining contact drop are likely to be more reliable in guiding an operator's judgment than specific figures made in different laboratories on apparatus of entirely different type. In so far as the load current is concerned it is desirable to have the contact drop as low as possible and for this reason brushes with high contact drop should be avoided on slip-ring service. On commutating types of apparatus, however, the contact drop of the brush performs an important function in suppressing the current within the armature coil which the brush is short-circuiting during the interval of commutation. On machines with poor commutation this characteristic may be the determining factor in selection of brushes.

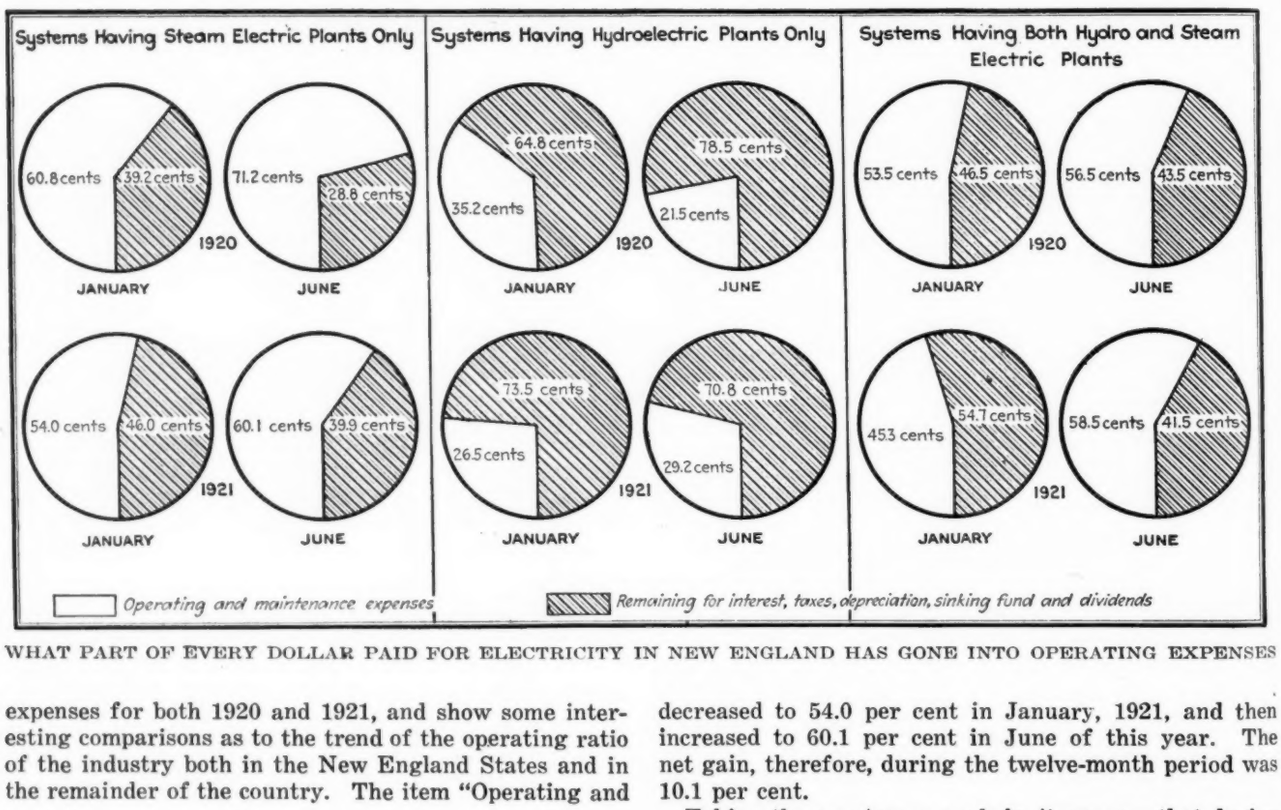
New England Generating Plants Show Decrease in Operating Ratio

Efficient Methods and Reduced Costs Have Decreased Operating Expense as Compared With Gross Revenue Received

ELECTRIC light and power companies of New England have made considerable headway during the last twelve months in the reduction of their operating ratio;[1] that is, the ratio between the "operating and maintenance expenses" and the "gross revenue from sale of energy," expressed as a percentage. The figures are reported on gross revenue and operating expenses for both 1920 and 1921, and show some interesting comparisons as to the trend of the operating ratio of the industry both in the New England States and in the remainder of the country. The item "Operating and Maintenance Expenses" does not include interest, taxes, depreciation or sinking fund.

In June, 1920, the electric light and power companies of New England, having steam generating plants only, reported an operating ratio of 71.2 per cent, which was the highest operating ratio reported by any section of the country. During 1920, however, the operating ratio decreased to 54.0 per cent in January, 1921, and then increased to 60.1 per cent in June of this year. The net gain, therefore, during the twelve-month period was 10.1 per cent.

Taking the country as a whole, it appears that during the present year the operating ratio of generating com-



WHAT PART OF EVERY DOLLAR PAID FOR ELECTRICITY IN NEW ENGLAND HAS GONE INTO OPERATING EXPENSES

[1]See the monthly statistics collected by the *Electrical World*.

AGGREGATE OPERATING RATIO OF ELECTRIC LIGHT AND POWER COMPANIES BY SECTIONS

Type of Generating Plant and Month	New England States		Average for Year		Atlantic States		Average for Year		North Central States		Average for Year		South Central States		Average for Year		Mountain and Pacific States		Average for Year	
	1921	1920	1921	1920	1921	1920	1921	1920	1921	1920	1921	1920	1921	1920	1921	1920	1921	1920	1921	1920
Steam Plants:																				
January	54.0	60.8	54.0	60.8	53.5	50.9	53.5	50.9	61.2	61.8	61.2	61.8	53.1	53.7	53.1	53.7	69.0	60.5	69.0	60.5
February	54.3	59.5	54.2	60.3	52.3	53.0	52.7	52.1	63.0	57.9	61.1	59.8	59.1	51.2	56.2	52.3	60.2	60.3	64.3	60.3
March	64.0	70.0	56.7	62.5	54.5	56.7	53.3	53.7	58.4	59.7	60.8	59.8	53.3	50.9	55.0	51.9	68.4	62.5	65.9	61.2
April	59.4	63.5	57.3	62.7	50.9	54.3	52.8	53.8	54.8	61.2	59.3	60.2	54.1	52.8	54.7	52.1	53.7	53.7	61.8	58.6
May	63.2	69.1	58.3	63.8	56.2	58.6	53.4	54.5	54.7	63.3	58.5	60.8	53.3	56.0	54.4	53.0	55.0	57.0	59.9	58.3
June	60.1	71.2	58.7	64.9	55.8	59.5	53.8	55.3	56.6	68.3	58.3	61.8	55.3	60.0	54.6	53.8	53.4	56.2	58.6	57.8
Hydro Plants:																				
January	26.5	35.2	26.5	35.2	21.1	21.2	21.2	21.2	25.0	20.8	25.0	20.8	26.4	20.1	26.4	20.1	27.5	27.3	27.5	27.3
February	30.1	36.5	26.8	35.6	20.1	20.6	20.7	20.9	24.1	20.6	24.6	20.6	28.6	21.4	27.4	20.5	23.9	27.9	26.0	27.6
March	29.9	30.0	26.9	35.3	21.0	20.6	20.8	20.8	23.0	20.6	23.5	20.6	30.4	23.2	28.4	21.3	24.9	19.0	25.8	25.6
April	24.6	34.7	26.5	35.2	18.2	18.8	20.2	20.3	24.8	20.8	24.2	20.7	22.4	25.0	26.8	21.2	27.3	19.2	26.0	24.2
May	26.5	25.6	26.5	34.3	15.5	17.4	19.2	19.7	21.5	20.1	22.5	20.5	27.9	21.2	27.1	21.2	29.8	22.9	26.6	24.0
June	29.2	21.5	26.6	33.8	17.6	18.8	19.0	19.6	21.1	19.5	22.8	20.2	27.3	18.3	27.1	20.7	30.3	27.4	27.6	24.2
Combined Systems of Steam and Hydro Plants:																				
January	45.3	53.5	45.3	53.5	43.5	45.8	43.5	45.8	39.5	38.6	39.5	38.6	38.6	46.6	38.6	46.6	35.2	45.6	35.2	45.5
February	44.3	60.0	44.7	58.8	41.8	41.9	42.6	43.8	42.4	49.8	41.9	48.2	41.7	39.6	40.5	42.0	39.6	43.8	37.4	44.7
March	49.7	53.8	47.3	56.0	39.7	47.3	42.0	45.3	41.5	46.0	41.8	47.3	38.6	39.2	40.2	41.2	36.4	39.7	36.9	43.0
April	46.6	48.5	47.1	53.5	42.9	43.9	41.9	44.8	45.0	48.3	42.7	47.5	43.6	48.6	40.7	42.8	37.0	36.8	37.0	41.0
May	49.2	48.5	47.6	52.3	39.8	44.2	41.4	44.7	47.0	52.8	43.7	48.8	40.7	39.6	40.6	42.2	35.0	38.3	36.4	40.3
June	58.5	56.5	49.6	53.2	42.3	45.8	41.6	44.9	50.1	62.2	45.0	51.6	45.1	44.8	41.3	42.7	38.8	44.3	37.0	41.1

panies having steam plants only was, on an average, the same during June as during January; namely, about 56.2 per cent. During 1920, however, the operating ratio increased from 55.3 per cent in January to 62.5 per cent in June. These comparisons can be fully explained by the rapid advance in the price of fuel during the spring of 1920 and the stability of fuel prices during the first six months of 1921.

There are so few generating companies in New England having systems operated entirely by hydro-electric plants that operating figures for this type of system are more or less erratic. The companies of this class reporting indicated that while in 1920 the operating ratio decreased from 35.2 per cent in January to 21.5 per cent in June, the reverse was shown in 1921; namely, from 26.5 in January to 29.2 in June. These companies are dependent entirely on stream flow, and the unusual low water experienced in practically all drainage areas of the eastern section of the United States last spring and summer is probably accountable for the high cost of operation and decreased revenue for this type of system.

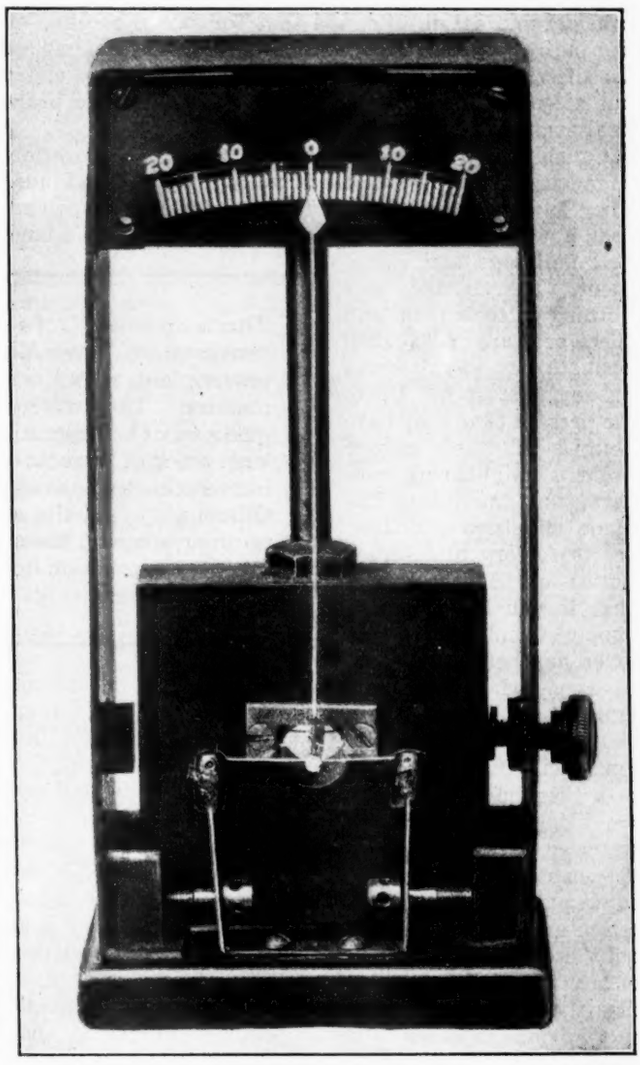
The country as a whole reported quite different figures for companies having systems with hydro-electric plants only. This class of companies reported a decrease in the operating ratio during the first six months in 1921 from 26.8 per cent to 20.4 per cent and from 27.0 per cent to 21.6 per cent during a similar period in 1920. This decrease is, however, to a greater or less degree, only apparent, for as the season advanced, many companies operating small hydro-electric plants, added auxiliaries to their systems and their reports of operation were, therefore, transferred to "Companies Having Both Hydro and Steam Plants." This transfer left only the companies having the larger hydro-electric plants, the operating ratio of which is, in general, below that of the smaller plants.

Operating ratios of companies having both hydro-electric and steam plants follow more or less the high-water and low-water periods of the rivers of the country. As the amount of water available decreased with the spring and early summer months, these companies were forced to increase their steam-plant operation as the hydro-plant output decreased. In New England the operating ratio gradually increased, therefore, from 45.3 per cent in January to 58.5 per cent in June during the present year and from 53.5 to 56.5 per cent during a similar period in 1920. Here again the usual low-water conditions were directly the cause of the large increase in the operating ratios of these companies during the present year. Considering the country as a whole, the operating ratio of this class of electric light and power companies gradually increased from 38.1 per cent in January to 45 per cent in June during the present year, and from 45.6 to 50.9 per cent during a similar period in 1920.

Figures for the country as a whole are even more significant when the fact is taken into consideration that the gross revenue of the electric light and power companies from the sale of energy during June, 1921, was almost 10 per cent greater than that reported in June, 1920. This increased revenue was realized during a period in which the cost of manufacturing electrical energy was decreasing, and this resulted in revenue above operating expenses greatly in excess of the amount possible had these two quantities increased proportionately. The New England electric light and power companies, while not following the remainder of the country to such an extent, nevertheless, reported a much larger decrease in operating expenses than in gross revenue. The gross revenue of the companies in this section in June, 1920, was $6,540,000, as against $6,420,000 in 1921, a decrease of 1.8 per cent, and the operating and maintenance expenses were reduced from $3,970,000 in June, 1920, to $3,730,000 in June, 1921, or a decrease of 6 per cent.

Vibration Amplitude Indicator

What is known as a vibration indicator has been developed to measure quantitatively the motion of vibration of any external portion of a turbine generator set,



VIBRATION AMPLITUDE INDICATOR, COVER REMOVED

either transverse or longitudinal. The scale is calibrated in thousandths of an inch.

The indicator consists of a cage supporting a relatively heavy weight as a pendulum. When the cage is placed on the part to be tested, the motion of the part is transmitted to the cage, while the weight remains stationary. The relative motion between the cage and the weight actuates a pointer that measures the amount of the motion definitely and accurately.

The ability to determine the effect of change in balance weights or other conditions is an improvement over former methods. The indicator is made by the G. E. Co.

Power Plant Accounts—VII. Interest

BY WILFRED A. MILLER

AMONG the elements of indirect cost of the manufacture of power there are some that introduce interesting problems in themselves and in their relation to investment. These are, interest, depreciation and obsolescence.

In a previous article the importance of including these items among the indirect expenses was drawn to our attention, and we went through the different steps of getting them into our records. The method of arriving at our entries for depreciation was gone into in considerable detail. So was that for taxes, another of the indirect items. Not much was said, however, about the distribution of interest, and therefore it may claim our attention for a little while. Let us take up a practical example in this connection.

Consider the case of Smith & Co., a corporation engaged in manufacturing articles of various kinds. They have been in business for a number of years and they now own their factory free and clear—all the land and buildings and equipment. That is, they owe nothing on their plant and therefore are not called upon to pay any interest on any part of it. Up to the present time they have bought all their power from a neighboring concern, but the latter has made extensive additions to its factory and serves notice on Smith & Co. that it will be unable to supply them with power after another six months have passed. Being confronted with this situation, Smith & Co. decide to build and operate their own power plant. However, they find that they cannot pay for the construction and equipment of such a plant out of the cash they have in the bank now nor out of what they are likely to have there in the near future. In consequence of this they decide to raise the required money by means of a "bond issue." That is, they will have bonds printed, and the total value of these will be equal to the amount of money they want to raise. They will sell these bonds to the "public," meaning whoever wishes to buy them. Upon studying the conditions, they find that they will have to offer to pay 8 per cent interest on the bonds in order to induce people to buy them, and accordingly that is the rate of interest decided upon. To build and equip the power station will cost $150,000, and the bond issue is therefore made of this amount.

> This is the seventh of a series of articles written in conversational style and treating the subject of power-plant accounts in a thorough, yet simple manner. They were prepared primarily for the guidance of the operating engineer who wishes to keep track of the cost of the power he is making, but who knows nothing at all about bookkeeping. Others may find the articles helpful in clearing up their ideas on the subject. This installment takes up interest on borrowed money, profit and related subjects.

When a concern decides to issue bonds for any purpose, an estimate is made of how soon it is thought the money received for the bonds can be returned to the purchasers, that is, the bondholders. This time will vary greatly, sometimes being for only two or three years, sometimes for fifty or more, depending on the purpose and the size of the issue. Whatever time is settled upon is made part of the agreement in selling the bonds; that is, the concern obligates itself to pay back the money to the bondholders at the end of that time. In our case we find that Smith & Co. have settled on ten years as being all that will be required for them to be able to pay off their bond issue. Consequently, we find that they are issuing $150,000 worth of bonds at 8 per cent interest, to "mature" in ten years from the date of issue.

The bonds are successfully sold, and with the money so obtained the power plant is erected. It is completed in time to put it into operation when the former source of power is shut off. Immediately, all the expenses attendant upon the generation of power begin. We have to hire labor, buy coal and so on. In addition to these direct expenses we must provide for all the indirect expenses, among which interest is an important item. Since the bond issue was negotiated for the express purpose of paying for the power plant, it is evident that the interest on it must be added to the cost of generating power, for if there were no power plant there would be no interest to pay. The interest is to be entered each month and is of course one-twelfth of the interest for the year, which is very simply arrived at. Thus we have, interest for one year = 8 per cent of $150,000 = 0.08 × 150,000 = $12,000, and consequently, interest for one month = $\frac{1}{12}$ × 12,000 = $1,000. Hence, at the end of each month we will make a journal entry, "Indirect Expense, Interest, $1,000," entering the amount in the left-hand column as usual.

The example just discussed presents the application of interest expense to power cost in its simplest form. There is no question but that the loan was negotiated for the express purpose of building and equipping the power house, and consequently no question can arise as to the correctness of applying the interest for it to the cost of power. The application of interest is generally, however, not quite so simple. A more general case will be taken up in the shape of another practical problem.

The Jones Co. is, like Smith & Co., the manufacturer of a variety of articles. Its business has been growing so rapidly of late that the directors have decided to build a branch factory in another town. To provide money for the project, they decide to issue bonds for the amount required. This action is taken and the bonds are successfully "floated." They are for $600,000 at 6 per cent interest and mature in fifteen years. However, in issuing them the company stipulates that if it finds itself in a position to do so, it may begin "calling," that is, paying off, the bonds before the fifteen years are up.

With the $600,000 received from the sale of the bonds, the Jones Co. proceeds to construct its new factory, one part of which is a power house. When this is ready to operate, we are hired to take charge of it, and find that we have here an excellent opportunity to begin keeping cost records right from the start. When, in the course of our accounting, we get to the item of interest,

we of course want to know how much it amounts to. We find out that it cost $600,000 to build the factory, but nobody can tell offhand how much the power plant cost. We shall then have to dig through the construction costs, or have someone do it for us, to arrive at some idea of the cost of construction. Let us say that we find it to be $50,000. Then the power house costs $\frac{50,000}{600,000} = \frac{1}{12}$ of the entire factory, and should therefore bear 1/12 of the interest expense. Since the total interest is 6 per cent of $600,000 = 0.06 × 600,000 = $36,000 per year, the cost of interest for power would be 1/12 × 36,000 = $3,000 per year. This would make the monthly entry in the journal 1/12 × 3,000 = $250 per month.

After three years the Jones Co. finds that it is in a position to pay off 10 per cent of its bonds, and that much of them is therefore called in, making 10 per cent of $600,000 = 0.10 × 600,000 = $60,000. Since 10 per cent of the bonds have been redeemed, there will, in the future, be 10 per cent less interest to be paid each year. If we spread this over the entire plant, the power house's share will be 10 per cent of $3,000, or 0.10 × 3,000 = $300 per year, which makes 1/12 × 300 = $25 per month. Therefore, after the third year our monthly entry in the journal for interest will be $25 less than before; that is, it will be $250 — 25 = $225 per month.

Another Practical Example

The foregoing are some of the phases presented by the subject of interest. It has many other angles. Thus, an argument similar to the following is sometimes heard: Old man Jones bought out the village electric-light plant. He put up $40,000 and there are mortgages of $60,000 on it at 6 per cent. From this it is apparent that his expense for interest is 0.06 × $60,000 = $3,600 per year. He says that he is entitled to charge the same rate for the money he has in the plant—that is, 0.06 × 40,000 = $2,400 per year—because if he didn't have it in the power plant he would have it salted away somewhere else, drawing interest for him at 6 per cent. So he's going to add that much to his expenses to get at what it is costing him per kilowatt-hour to generate power, so that he can make a new rate for service to the village. Such an argument is all wrong. It is decidedly incorrect to make a charge for interest on money we have invested in a business, as one of the expenses. Let us look at it this way: At the end of a year Jones finds that he has furnished 350,000 kw.-hr. and that his total cost without interest on his $40,000 has been $45,000. That is the actual amount of money he has spent to produce 350,000 kw.-hr. of electrical power. The total amount that he gets for the power should, of course, be more than it cost him, so as to give him a profit. The question is, How much profit shall he add? Profit, theoretically at least, should be based on investment. We won't think about how often it isn't. Accepting it as the correct basis, let us say that we will allow Jones 10 per cent on his investment, of $40,000. That will make 0.10 × 40,000 = $4,000 to add to his cost to get at the amount he ought to charge. Hence we have, selling price = 45,000 + 4,000 = $49,000. The price per kilowatt-hour would therefore be $\frac{49,000}{350,000}$ = 14 cents. Suppose now that he *had* included interest on his own $40,000 as well as on the $60,000 mortgages. That would have made an apparent addition of 0.06 × 40,000 = $2,400 to his cost, making it 45,000 + 2,400 = $47,400, and apparently justifying him in charging 47,400 + 4,000 profit = $51,400 total, and making the rate $\frac{51,400}{350,000}$ = 14.7c. per kw.-hr. What became of this interest? Did he pay it to someone else? Did it pass out of his possession in any way? No. He paid it to himself. Therefore he gets not only the $4,000 profit, but also the $2,400 interest, or a total of $4,000 + 2,400 = $6,400. Since his investment is $40,000, he would be making an interest rate of $\frac{6,400}{40,000}$ = 0.16, which multiplied by 100 to convert it into percentage would give us 0.16 × 100 = 16 per cent. If he had had the money out somewhere else at 6 per cent, he would have received only $2,400 on it, yet according to his original argument he wants to get this and then get 10 per cent in addition. It is obvious that if he figures his profit at 10 per cent on his investment, he is already getting more for it than if he had it put away somewhere at 6 per cent.

Sometimes profit is figured as a percentage of cost instead of as a percentage of investment. This, however, does not change the underlying principles. It merely means that if the sales are large the profit will be large and if the sales are small the profit will shrink correspondingly. In that case the rate of profit will change if the investment remains constant. This side of the question need not concern us. All that it is necessary for us to know is that we must distinguish between interest that is actually being paid on money borrowed, and that which it may be claimed should be allowed for money invested in the plant. The latter we must never allow to be entered as an element of expense in the generation of power or, for that matter, anything else.

Repayment of Loans

Another feature that sometimes causes trouble in the accounting is that of the repayment of loans. For instance, in one of our examples we found that the Jones Co. paid off 10 per cent of their bond issue of $600,000 after three years. That is, they returned 0.10 × 600,000 = $60,000 of the money borrowed by them on their bonds. Where does this money come from? In fact, where do we get the money to repay the bondholders at maturity, irrespective of whether or not we call in any of the bonds before that date? In order to have it ready at the proper time, we must set aside a certain amount of money periodically, every month or every year. Is this not an expense which we must include with interest? Not so. The situation will be made clear by following out the example of Smith & Co., which we used earlier in this discussion. Smith & Co. issued $150,000 worth of bonds to raise money for building a power station, which bonds they obligated themselves to redeem in ten years. In order to have the $150,000 ready at the end of ten years, they put aside $15,000[1] each year.

As just stated, this $15,000 is not an expense. The conditions are these: Smith & Co. borrow $150,000

[1]As a matter of fact, it would not be necessary to put by that much each year, since the money so put aside could be put out at interest, and the interest added to the principal. Hence, if $15,000 were put aside every year for 10 years, that in itself would amount to 10 × 15,000 = $150,000. The interest added to it would make considerably more money available. Consequently, an annual sum less than $15,000 will do. However, this is a mere detail which need not be injected into our discussion.

from a number of people, or for the sake of argument let us assume that a single individual, A. A. Abbie, has taken the entire bond issue. Evidently, the money belongs to Abbie, not to Smith & Co.; they have only borrowed it from him. What do they do with it? They build a power plant for themselves with the money. That is, they exchange the money for a power plant. But the money belongs to Abbie, hence the power plant belongs to him, because all that Smith & Co. have done is tc change Abbie's money into a power plant. If the money does not belong to them, then what they exchange it for cannot belong to them either. And this is really so. If Smith & Co. failed to pay interest to Abbie on his bonds, he could demand back his money or its equivalent, as for example, the power plant. Now the condition which exists when Smith & Co. pay Abbie his $150,000 at the end of ten years is that Abbie gets back his $150,000 and Smith & Co. have a power plant which belongs to them free and clear. The situation is analogous to the one we would have if Smith & Co. had been saving up $15,000 a year for ten years before they were called upon to build their power plant. Then they would have had the money available for the purpose and would not have had to borrow it. In that case the question of including the $15,000 installments as an expense of generating power would never arise, because the power house would be fully paid for when ready to operate and there would consequently be no installments after completion. Just because the installments happen to be set aside after the plant is put into operation instead of before, is no reason for saying that they are an expense.

The point to bear in mind is, that before any change may be entered as being an element of cost, we must satisfy ourselves that it is for something that is "used up" in the manufacture of power. It may be argued that the plant is gradually being used up, and that therefore we should charge as an item of cost any payments made for it. But we must remember that we are making an entry for depreciation each month and that this takes care of the using up of the plant. Certainly, if we planked down the entire $150,000 when we started to build the plant, we would not charge it in as an expense of generating for the first month or the first year. We would only charge as an expense that part of it which we had used up, which would be taken care of under the heading of depreciation. Just because we pay for it in ten installments of $15,000 each instead of in one lump sum of $150,000 does not, it is clear, make any change whatever in the situation.

Making One-Piece Baffles—Patching Boiler Settings

THE importance of tight boiler baffles that will stand up under forced firing and will not develop cracks and leaks with extreme temperature variations, is fully recognized. Losses due to faulty baffle designs and construction often constitute a considerable percentage of the total B.t.u. lost in evaporation. Tight baffles insure increased steaming capacity and fuel saving.

To show that bafflings can be placed that will hold up under the severe temperatures of modern boiler practice the following is of interest: Concrete baffles using a high-temperature cement to bond the aggregate were installed at the plants of the Queens Borough Gas and Electric Co., New York City, over three years ago. In tearing out the boiler setting for the purpose of installing larger boilers, an opportunity was given to examine the condition of the baffles, which were in as good shape as the day they were poured.

The same method and materials were used in putting in baffles for the new boilers as shown in the illustrations, Figs. 1 to 5. Wood forms (pine, spruce or cypress preferred) were assembled in accordance with Fig. 5 in the following manner:

Two 2 x 4-in. stringers or nailing pieces were placed parallel on top of the tubes centering on the proposed baffle, these stringers being of sufficient length to take

FIG. 1. PUTTING THE DIAGONAL SLATS IN PLACE

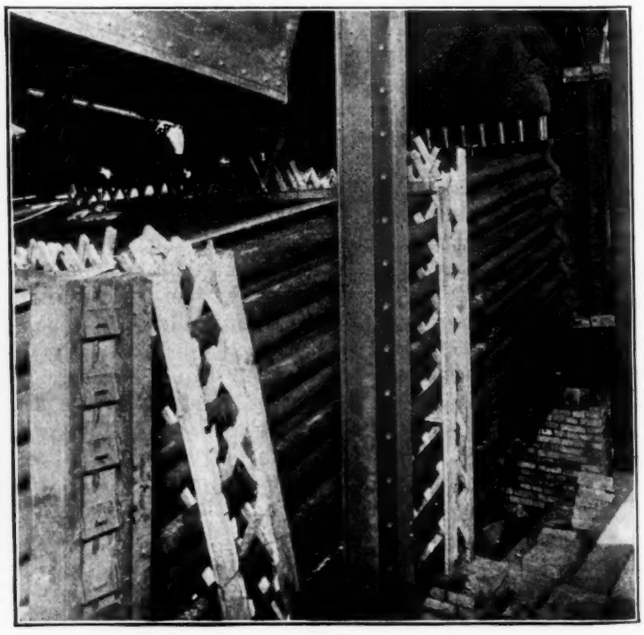


FIG. 2. FORMS WITHOUT BLOCKING-OFF PIECES

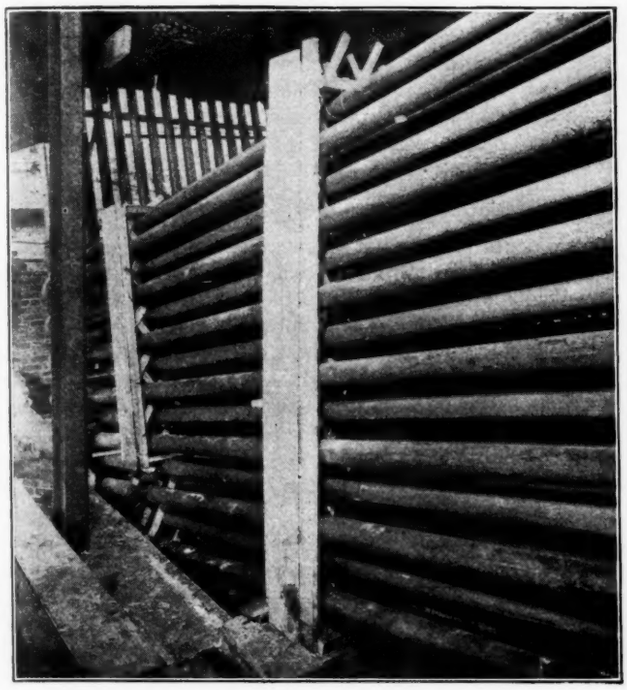


FIG. 3. BLOCKING-OFF PIECES IN PLACE

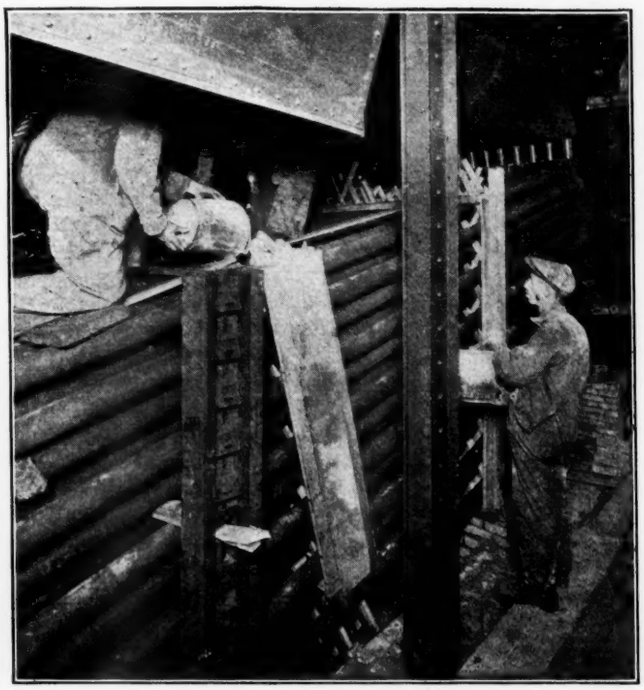


FIG. 4. POURING AND RAMMING THE CEMENT

care of blocking-off piece, or extension if it is desired to carry the baffle into the boiler wall. Two more stringers were placed under the row of tubes which mark the bottom of the proposed baffle. The position of these stringers depends on what angle the baffle takes with relation to the tubes.

Slats 1 x 2½ in. were then placed diagonally down between the tubes, as shown in Fig. 1, and nailed securely to stringers at the top and bottom. Where the strips cross one another, the latter should be reinforced. The forms will then appear as shown in Fig. 2. Blocking-off pieces are nailed on as shown in Fig. 3, or extensions made as desired.

The high-temperature cement is diluted with water in a mortar box placed on the floor in a convenient spot. Enough water is added to the cement so that when it is worked smooth it will have the consistency of a pancake batter. To this batter carbosand is gradually added, care being used to see that the two are thoroughly mixed. The mixture should be a little more moist than molding sand. Using a pail of this mixture at a time, enough water is added to each pail to permit pouring, but no more water than is necessary. Too thin a mixture will work out through the lattice.

A man with a light is stationed under the tubes near the bridge wall, to direct the pour. Two men on top of the tubes pour and ram the baffle, one of them working a thin strip up and down at the point of pouring, to prevent pockets or voids.

Fig. 4 shows the pouring and ramming operation; the use of high-temperature cement bonds the aggregate to form a solid one-piece baffle of refractory concrete. The wood form is burned up when the fires are lighted.

No trouble has been experienced when withdrawing tubes and in fitting new ones when necessary. If the baffle is slightly fractured, repairs are made by mixing a high-tempered cement with water to the consistency of mortar and applying the mixture to the broken part by means of a long strip of wood.

The same material can effectively be used on some difficult repairs. The life of boiler settings can be prolonged by careful attention to patching when opportunity affords. Small cracks or open joints, if attended to before the bricks become loosened, will save a more serious repair job.

Large patches or other repairs using this cement as a binder for crushed firebrick or special granular refractories, have been successfully made on many types of furnaces. These patches are troweled on the surface of the patch and coated afterward with diluted high-temperature cement.

All boiler settings will develop weak spots sooner or later. The average operating engineer realizes that a well-applied patch, made with the proper material, may save a lengthy job of reconstruction and also prevent a shutdown. Many attempts have been made to repair side walls and arches on boiler settings, but the results have often proved a failure and the operating engineer has been discouraged in his efforts to make a patch that will stay put. A method of patching that has proved satisfactory in a number of central stations and industrial plants is shown in Figs. 6 and 7.

Patching suspended or horizontal surfaces or flat arches and the filling of deep and extended abrasions in side walls and bridge walls have been made with success by using a high-temperature cement as a binder for the refractory filling. Successful patches have even been made in cases where the side walls six feet square have been eaten away six to eight inches deep. The brickwork has been restored to its original thickness and the patch has stuck.

Where brick has spalled in the arch, the crevices have been filled and the arch restored to its original alignment. The cement requires no heat to effect a bond, so that the newly applied patch can be built up in the crevices or holes and become an integral part of the structure. Success in this work depends on the manner of application as well as the materials used.

The bad condition in which arches and bridge walls may get is shown in Fig. 6. Some of the suspended blocks in the arch are gone and the brickwork of both arch and bridge wall is badly eaten away. Fig. 7 shows

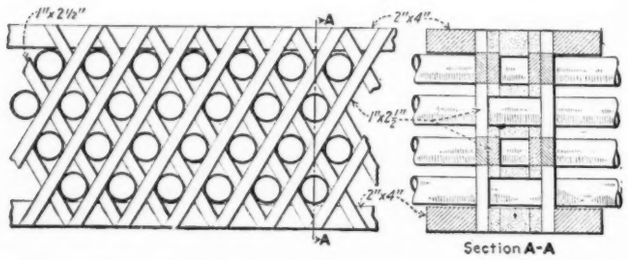


FIG. 5. HOW THE STRINGERS AND SLATS ARE ARRANGED

the arch and bridge wall after patching and ready for the finishing coat.

In applying the patches, the clinker was first removed and chipped and nicked until most of the glaze was gone and the original texture of the brick exposed. Care was taken in this work so that the bricks would not loosen. The surface to be patched was brushed until free from dust. This surface was then well saturated with a thin, milky wash of the high-temperature cement and water as a primary coat, which was quickly absorbed by the exposed brick surface.

The foundation for the patch, consisting of a somewhat thicker mixture, was then applied as a bonding coat. Where the surfaces were large, this was done in sections so as to insure a moist surface for applying the patching mixture, which consisted of diluted high-temperature cement to which carbosand was added gradually until thoroughly mixed. The consistency was such that no free moisture showed when the mixture was squeezed in the hand.

Care was taken to apply the patch while the foundation coat was still moist. After the patching was completed on all large and small surfaces, it was allowed to set for about an hour before applying a final surface of the same mixture as used for the bonding coat. The object of the final coating was to fill pores and small voids and give a smooth surface to resist pitting action of the flames and hot gases.

The photograph views shown were taken in a power plant of a large central station in the Middle West, and the work was done under the supervision of the Quigley Furnace Specialties Co.

Burning Powdered Coal Safely

A discussion on the preparation and burning of pulverized coal, especially with regard to the changes involved and precautions to be taken, was given in the *Travelers Standard* for September, published by the Travelers Insurance Co., Hartford, Conn. According to this article pulverized coal is not so dangerous that anyone should be afraid to use it, but on the other hand, it has disastrous possibilities that are roughly comparable to those of fuel oil and gas. In speaking of the danger of explosion from coal dust, mention was made of experiments conducted by the United States Bureau of Mines, which have proved that a mixture containing only 30 per cent of coal dust and 70 per cent of finely powdered shale could be exploded. The following precautions were suggested:

Artificial ventilation and well-designed vacuum cleaning apparatus should be used in keeping the plants clear of dust; the design of the drier should be such that there is no chance for hot gases to come in contact with the powdered coal, or for red-hot cinders to drop into the screw conveyor; a competent and thoroughly skilled man should be put in charge of the drying operation, as too high a temperature is likely to result in spontaneous combustion when the coal is in storage; care should be taken that the air pressure in the pipes through which the pulverized coal is distributed to the furnaces does not drop, as a back-fire is likely to result; storage bins should be kept as cool as possible, and should therefore be kept a safe distance from furnaces, steam pipes and other sources of heat.

FIG. 6. ARCH AND BRIDGE WALL BEFORE PATCHING SHOWING BRICK WORK EATEN AWAY

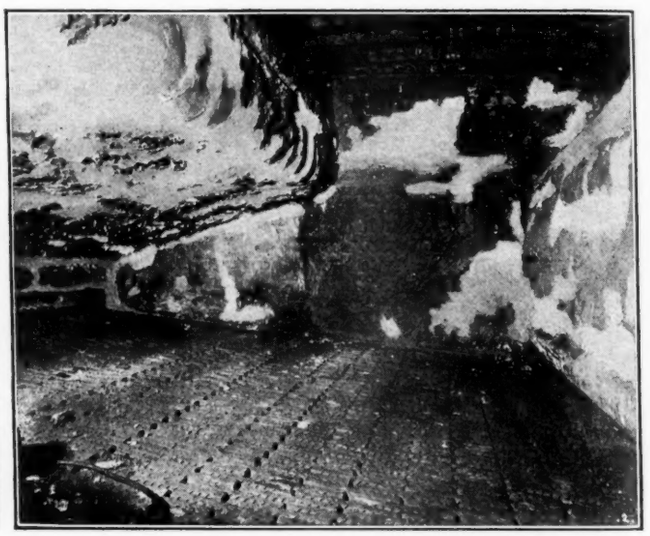
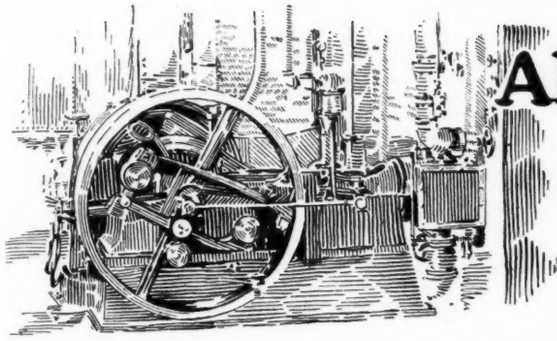


FIG. 7. ARCH AND BRIDGE WALL AFTER PATCHING WITH HIGH TEMPERATURE CEMENT

The 1921 central-station load in the United States is about midway between that of 1919 and that of 1920, and is following their fluctuations closely.



ADJUSTING SHAFT GOVERNORS

IT OFTEN makes it easier to understand the working of an unfamiliar piece of machinery if we can first study a diagram showing only the absolutely essential parts and depicting them in the relation that is easiest to comprehend. When the principles of this ideally simplified apparatus are understood, the mind can proceed by easy steps to an understanding of the various commercial types.

Some actual shaft governors depend for their action on centrifugal force alone, while others make use of a combination of centrifugal and inertia forces. Every man who has worked around machinery has some idea of how these forces operate, but it will do no harm to review the ideas involved and get them clearly in mind.

Fig. 1 shows an idealized type of shaft governor actuated purely by centrifugal force. For the sake of simplicity the connection of the weight B to the eccentric has been omitted. Let us assume that the engine is designed to run at 200 r.p.m. with a $\frac{3}{8}$ cutoff. The weight B is carried by a light arm pivoted at C and pulled inward by the spring F. On the shaft A is mounted an eccentric (not shown). This eccentric is movable and is connected by links with the arm CB in such a way that its position is changed when B shifts. For actual shaft governors the eccentric may shift to change the angle of advance, the eccentricity or both. The final effect desired in any case is to change the cutoff with the minimum disturbance of admission, release and compression. In the case under consideration the cutoff is assumed to be $\frac{3}{8}$ if the weight B is at the point shown. In this position CB is perpendicular to AB so that centrifugal force exerts its maximum effect. The connection to the eccentric is assumed to be such that the cutoff is $\frac{1}{4}$ when the weight is at D and $\frac{1}{2}$ when the weight is at E. Assume that the engine is running at exactly 200 r.p.m. with the tension at the spring adjusted to hold the weight at the position B at this speed. Obviously, the load on the engine must be such as to require a $\frac{3}{8}$ cutoff to carry it.

Suppose now the load is reduced to that which would require a $\frac{1}{4}$ cutoff. Since the actual cutoff is $\frac{3}{8}$, the engine starts to speed up. The increased centrifugal force causes the weight to move toward the rim of the wheel. As it moves out, it gradually decreases the cutoff. When the weight reaches D, the cutoff is reduced to $\frac{1}{4}$ so that it is just sufficient to carry the lighter load. The weight therefore stays at D as long as the load stays constant at the new point. The speed of the engine must obviously be a little above 200 r.p.m. to hold the weight at D. Assume that it is 205 r.p.m. If, now, the load is increased to the point where $\frac{1}{2}$ cutoff would be required to carry it, the actual cutoff of $\frac{1}{4}$ is insufficient, so the engine starts slowing down. The centrifugal force of course decreases at the same time so that the tension in the spring F draws the weight toward the center of the wheel. As the weight moves in, the cutoff increases. When the weight reaches E, the cutoff is $\frac{1}{2}$, which is sufficient to carry the load. Therefore there is no further decrease in speed and the engine continues to run at slightly less than 200 r.p.m. (say 195 r.p.m.) and with a cutoff of $\frac{1}{2}$.

Let us next consider a governor of the pure inertia

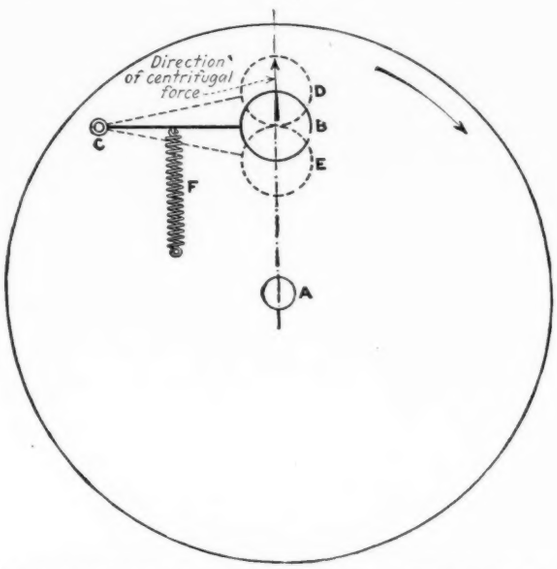


FIG. 1. SIMPLIFIED DIAGRAM OF GOVERNOR OF PURE CENTRIFUGAL TYPE

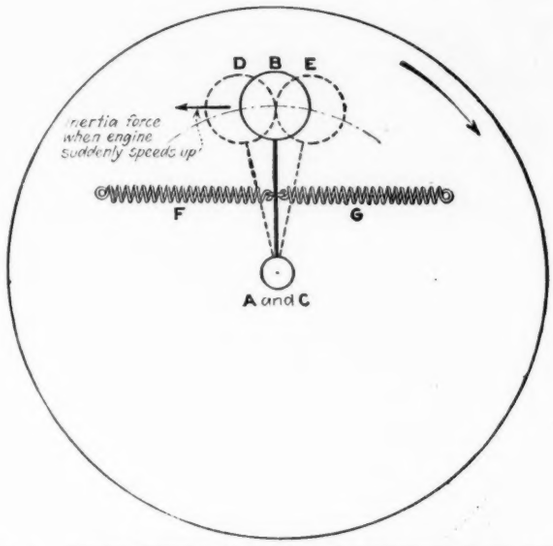


FIG. 2. SIMPLIFIED DIAGRAM OF GOVERNOR OF PURE INERTIA TYPE

type. For reasons that will be evident later, the pure inertia type cannot be used in practice. However, an understanding of it is necessary in order to understand the so-called inertia type of shaft governor, which is really a combination of centrifugal and inertia governor.

An imaginary form of this governor is shown in Fig. 2. In both cases the arm carrying the weight *B* is pivoted at a point *C*, which in this particular example is the same as the center of the shaft. However, the essential thing about this governor is that the line *CB* must be along a radius of the wheel. It will be recalled that in the case of the pure centrifugal governor the line *CB* was perpendicular to a wheel radius through *B*.

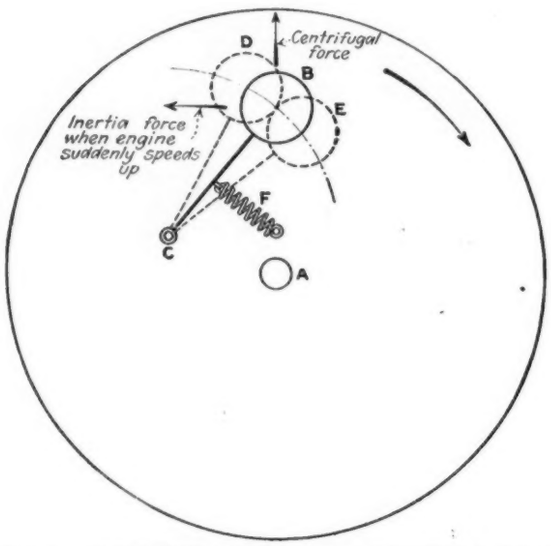


FIG. 3. SIMPLIFIED DIAGRAM OF GOVERNOR THAT USES BOTH THE CENTRIFUGAL AND THE INERTIA EFFECTS

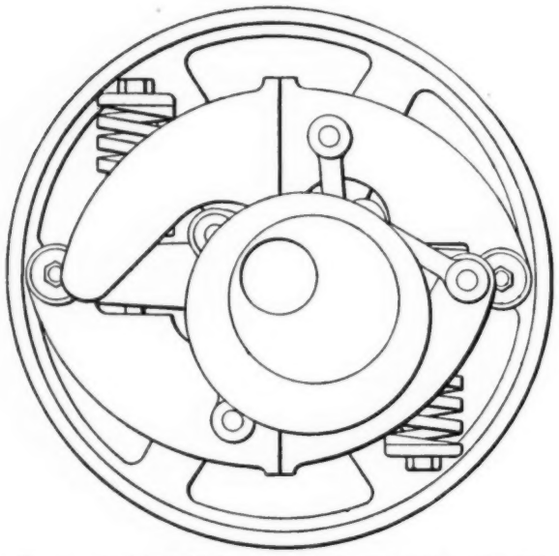


FIG. 4. CENTRIFUGAL TYPE OF SHAFT GOVERNOR

The arm *CB* in Fig. 2 is connected to the movable eccentric in such a way that the cutoff will be ¾ at *B*, ¼ at *D* and ½ at *E*. The weight is held by two springs *F* and *G* in such a way that it will be in the position *B* when at rest. Suppose the engine is running at 200 r.p.m. in the direction indicated, that the weight is at *B*, and that the load is exactly carried by a ¾ cutoff. If the load were now reduced suddenly to that requiring a ¼ cutoff, the wheel would speed up with corresponding suddenness and the weight, lagging back, would be suddenly moved toward *D*, thereby producing a very rapid reduction in the cutoff. The effect would, however, last only for a few moments, for the springs *E* and *F* would bring the weight back to *B* as soon as the speed stopped picking up. The speed might now be 210 r.p.m. with the weight back at its old position *B* and with a cutoff of ¾. Since this cutoff would be too great for the load, the operation would be repeated, bringing the speed to 220 r.p.m. stage. So the engine would speed up and run away. The opposite effect would occur if the load were increased to such a point that ½ cutoff would be required to carry it. In this case the engine would gradually slow down and finally come to a dead stop. It is therefore evident that the

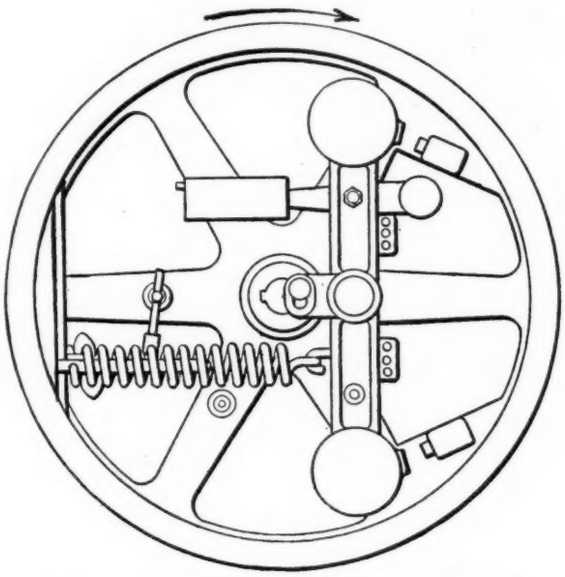
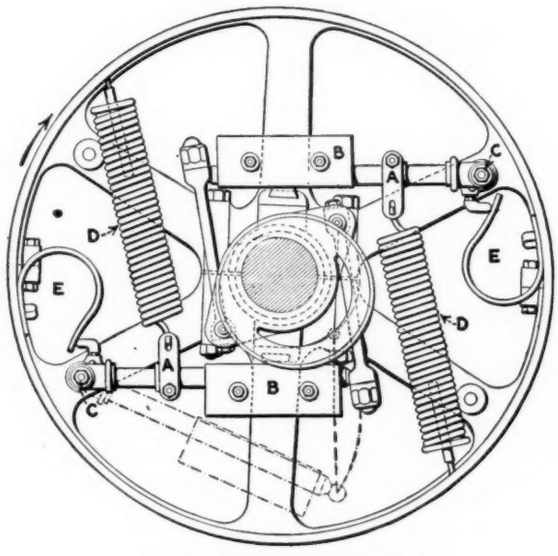


FIG. 5. INERTIA TYPE OF SHAFT GOVERNOR



IG. 6. BUCKEYE GOVERNOR

pure inertia type is extremely sensitive and effective in causing a rapid change in cutoff to counteract a sudden change in load, but that it is useless as a means of holding the engine at a practically constant speed. This is so because the weight comes to rest at *B* for any constant speed whatsoever.

Suppose it is desired to construct a governor that will

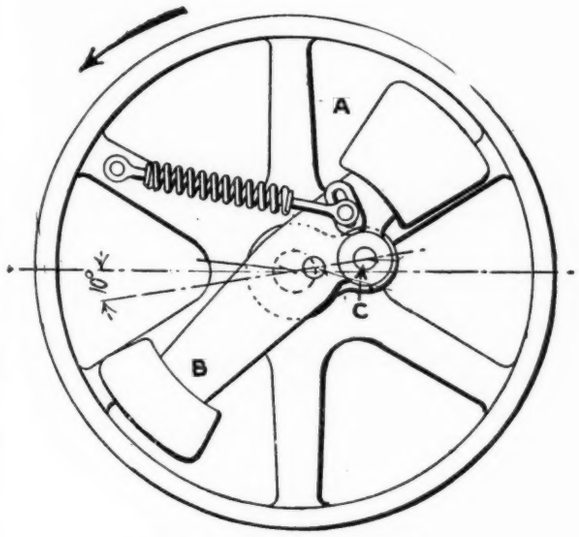


FIG. 7. RITES GOVERNOR

assume a series of definite positions (and cutoffs) for a definite series of constant loads, but that will at the same time have the quick reaction to sudden changes that is characteristic of the pure inertia governor. This can be accomplished by constructing a governor that is a "cross" between the pure centrifugal type and the pure inertia type.

Such a governor is shown in Fig. 3. Here *B* is

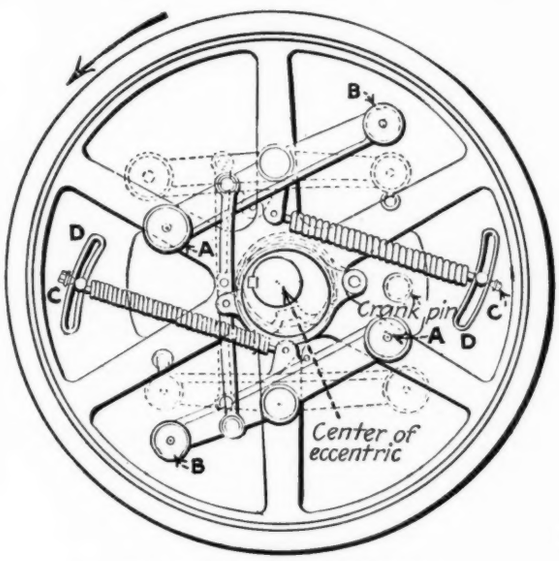


FIG. 8. FLEMING GOVERNO

located as in Fig. 1 and Fig. 2, but *C* is located between the two extreme positions. In other words, *CB* makes an angle less than 90 deg. with the line *AB*. As before, the position *B* gives $\frac{3}{8}$ cutoff, *D* $\frac{1}{4}$ cutoff and *E* $\frac{1}{2}$ cutoff, and the combination of spring, weight, etc., is such that the weight will stay at *D* for a constant speed of 205 r.p.m. and at *E* for a constant speed of 195 r.p.m. If, now, the speed is increased or decreased by 5 r.p.m. very gradually, the weight will move to the positions *D* and *E* respectively. The only apparent effect will be that of the centrifugal force, and the governor will act on the same general principle as the centrifugal governor of Fig. 1. If the speed is suddenly increased or decreased,

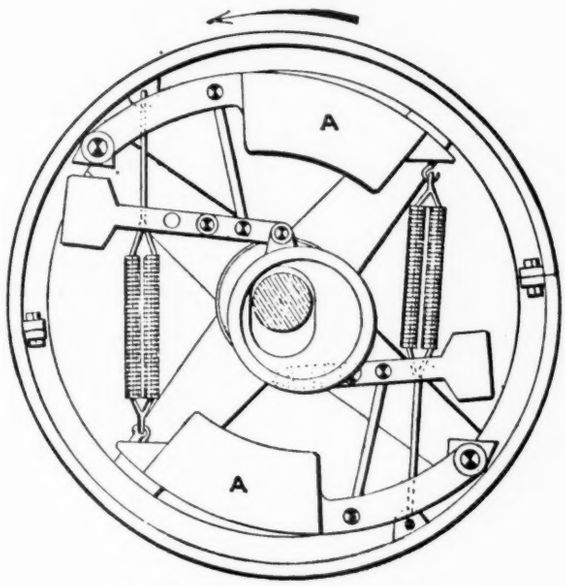


FIG. 9. FITCHBURG GOVERNOR

the inertia acting at right angles to *BA* will cause a sudden shift in the direction of *D* or *E* respectively. This effect will be more nearly instantaneous than the centrifugal effect and will help hold the engine in check until the weight comes to its new position of equilibrium. When this is reached and the load is constant, the inertia effect disappears and the governor is held

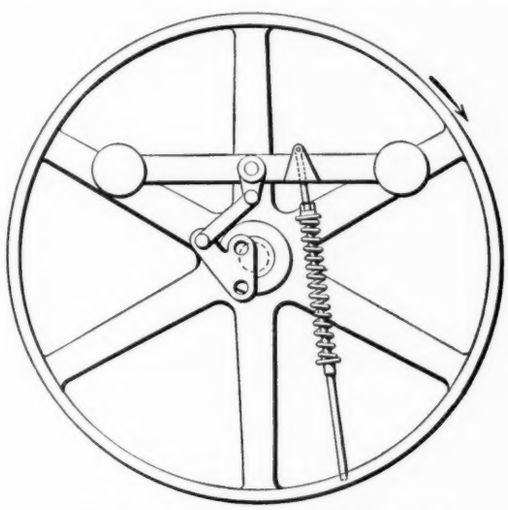


FIG. 10. BALL INERTIA GOVERNOR

in the proper new position by the balance between the spring and the centrifugal effect.

Governors operating on the principle of Fig. 3 are ordinarily called simply "inertia" governors, since there is in practice no pure inertia type with which they could be confused.

In commercial types of shaft governors there are

frequently two weighted arms instead of one; as shown in the diagrams just given. This does not, however, change the principle of operation in any way, as each arm acts in the manner indicated and the two combine their effects.

The type can be determined in a general way by drawing two arrows from the center of gravity of each weight. The first arrow points outward from the center of the shaft (not from the pivot of the arm). This represents the centrifugal effect. The amount of the pull depends on the size of the weight and the distance

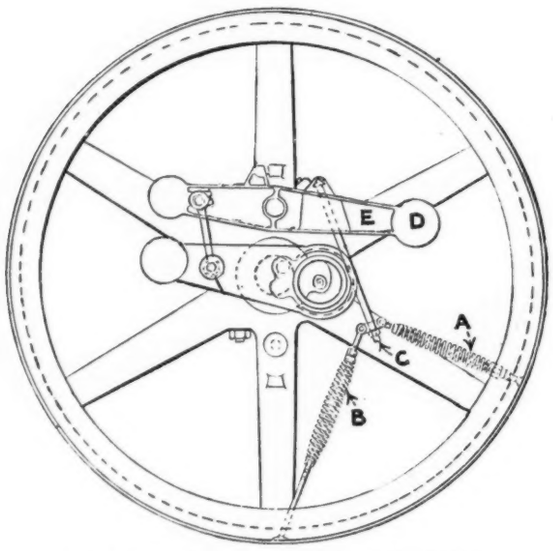


FIG. 11. BALL-BALANCED GOVERNOR

of its center of gravity from the center of the shaft. If the pivot of the weight is close to this line of pull, it is evident that there is less torque or twist tending to turn the arm to a new position than if the pivot were far from the line of pull. The inertia effect can be studied in the same way by drawing an arrow through the center of gravity of the weight at right angles to a line drawn from the center of the shaft to the center of the weight, and then seeing how effective a pull in that direction would be in turning the weight about its pivot.

Applying this method of analysis, it becomes evident that the governor shown in Fig. 4 operates almost entirely by centrifugal force, while that shown in Fig. 5 depends almost entirely on the inertia effect. It will be noticed, however, that there is some centrifugal effect in Fig. 5. This is necessary for the reasons already given.

In general, to adjust a shaft governor for a higher speed the weights must be decreased, or shifted in such a way that the centrifugal force has a smaller leverage, or else the spring effect must be increased by increasing either the tension or the leverage with which they act on the weighted arms. Any of these changes mean that a greater speed will be required to hold the cutoff at a given point and hence to carry a given load. The opposite changes will, of course, lower the speed.

A governor is said to be "sensitive" when a small variation in speed produces a large change in the cutoff and thus takes care of a large variation in the load. The sensitiveness practically obtainable is limited by the "hunting" effect that is produced if an attempt is made to secure extremely close regulation. The chief method of increasing the sensitiveness is to so adjust the spring or shift its connections that it will be distorted a smaller percentage of its length for a given shift of the weighted arm. Since these changes usually affect the speed also, it is usually necessary to change or shift the weights at the same time.

Buckeye Governor—In Fig. 6 is shown a Buckeye governor which has the springs so attached to the weight arms that the points of attachment can be moved toward or away from the weight pivots, thus giving more or less purchase and acting the same as more or less tension on the spring. If an increase in engine speed is desired, move the clips *A* which secure the spring to the weight arm toward the weight *B* and away from the pivots *C*. This will give more purchase and is equal to increasing the tensions of the spring. Moving the clips *A* toward the pivots and away from the weights, thus giving less purchase, will decrease the engine speed. Both clips should be moved alike, for the same reason that the same tension and weight should be placed on both springs and weight arms.

Changes in speed can be made by altering the spring up to the point where the variation in speed from full load to no load is reduced to a minimum, but any further change will tend to cause the governor to race if more tension is given to the springs or to grow sluggish if the tension is reduced. If the governor is sluggish at the required speed, increase the tension on the springs *D* and add weight to the weight arm, or lessen the purchase by moving the spring clips. If the engine races, decrease the tension on the coil springs and remove weight from the weight arm, or increase the purchase.

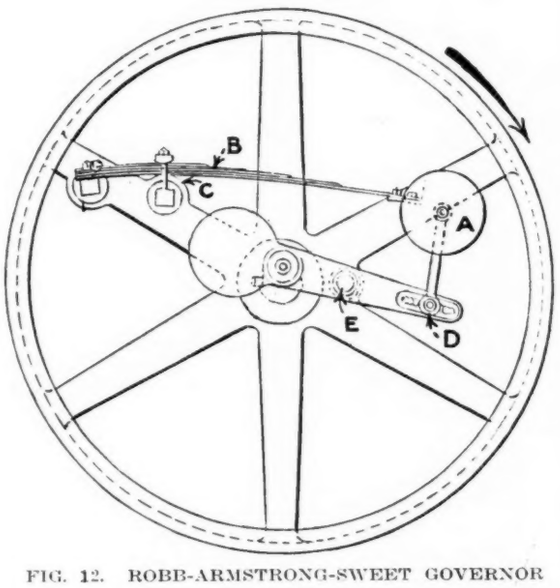


FIG. 12. ROBB-ARMSTRONG-SWEET GOVERNOR

If it slows down below the rated speed with full load, increase the tension and decrease the purchase. The flat auxiliary springs *E* are used to assist in throwing the weight out through the inner half of the movement, after which they do not have contact with the weight arm and cease to act.

In changing the tension on the springs, care should be taken to avoid making the governor either too sensitive or not enough so, for if the change is too radical the engine may race, or with a light load it may attain its proper speed but slow down below the desired speed when full load is thrown on.

Rites Inertia Governor—The Rites inertia governor, Fig. 7, has a single weight arm that swings about a supporting pin and carries an eccentric. By adjusting the two weights, centrifugal force is made to act through a point a little to the left of the pin, but is resisted by the spring that is attached to a sliding block in the weight arm and to the spoke or rim of the governor wheel. The engine speed is regulated by adjusting the weights *A* and *B*.

A shifting of weights that carries the center of gravity farther to the left of the pin *C* will require

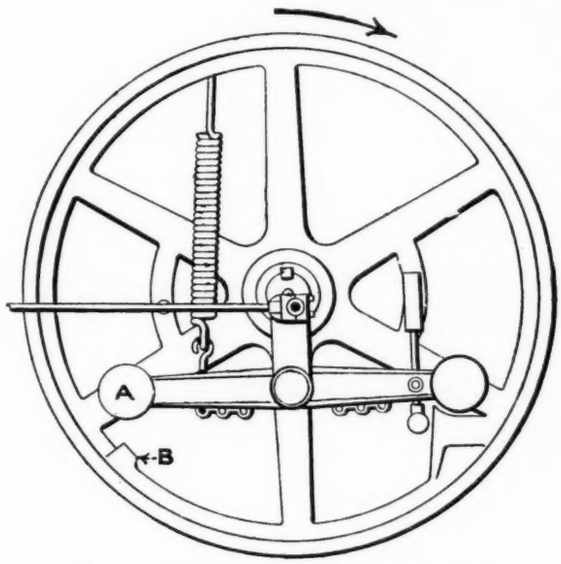


FIG. 13. BEGTRUP INERTIA GOVERNOR

a greater spring tension. Adding weight at *A* will move the center of gravity to the left, and removing weight from *B* will move the center of gravity to the right of the pin.

When making governor adjustments to increase the speed of the engine, it is preferable to increase the spring tension and add more weight to *A* than is thought to be required, and then by trial gradually remove weight from *A* until the regulation is as close as needed. The operation is reversed when it is desired to reduce the speed.

This governor is modified in regard to some of its parts in that the weight pockets are divided so that an easy adjustment can be made. Adding weight gives less speed and removing weight gives increased speed. If the governor is sluggish, give more tension in the spring and less purchase on the sliding block. If the engine races, give less tension on the spring and more purchase. It is advisable to give as little initial tension on the springs as possible to get the proper sensitiveness and so reduce the strain on the bearing as much as possible.

Fleming Engine Governor—This governor is of the centrally-balanced centrifugal-inertia type. The speed can best be changed by taking weights from the large ends of the weight arms and adding weights to the small ends, for increased engine speed, and just the opposite for decreased speed. The springs are adjusted by bolts *C*, as shown in Fig. 8. If, after adjusting the springs, the engine runs too fast, add weight of equal thickness to each of the weight pockets *A* and *B*, placing the weights of larger diameter in the pocket *A* and those of smaller diameter in *B*. Keep adding weights of equal thickness until the proper weight is had to give the desired speed.

If the governor races, move the clamps to which the outer ends of the springs are attached in the slots to bring them farther from the wheel rim, or toward *D*. If this does not correct the tendency to race, screw the spring plugs farther into the springs and adjust the tension for the proper speed. Removing thin weights of equal thickness from each pocket and reducing the spring tension also assists in checking racing.

If the governor is sluggish, add a thin weight of equal thickness to each pocket and increase the spring tension, but not too much or the spring may be damaged. If still greater sensitivensss is desired, move the outer spring clamp in the slot nearer to the wheel rim. The governor may be made more sensitive by screwing the plug a part of a turn out of the spring and increasing the tension.

Fitchburg Governor—In the Fitchburg governor, Fig. 9, there are two sets of weights. The small ones are to counterbalance the weight of the valves, stem and eccentric and are not to be considered in the adjustment of the governor. The weights *A* are changeable. Adding weight decreases the speed and removing weight increases the speed. The weight arms are opposed by springs that are attached to the weights, as shown. There is no provision for easily changing the weights, and the springs are designed to have enough range of adjustment without injuring the sensitiveness to vary the speed to meet most requirements. To obtain more speed, tighten the springs. To decrease the speed, slacken the springs. If more sensitiveness is required,

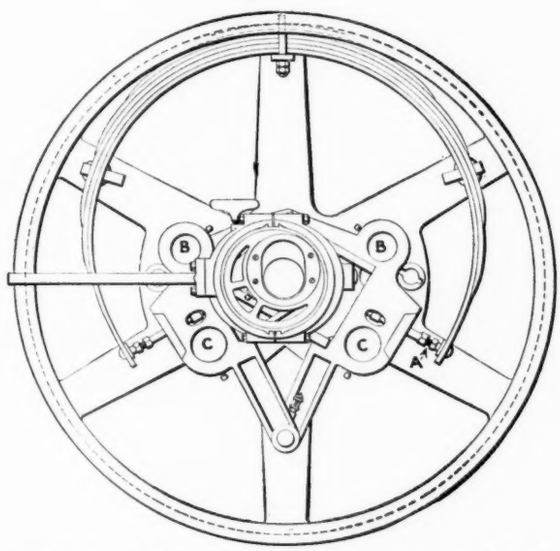


FIG. 14. McINTOSH & SEYMOUR GOVERNOR FOR LARGE ENGINES

increase the tension on the springs, or if the speed is what is desired, increase the tension and weight at the same time to keep the speed the same as before adjustments were made. To make more sluggish, decrease the spring tension and if the speed is right, decrease the weight also to keep the speed at the same point.

If the engine should slow down below the rated speed with full load, the increase of tension on the springs would require the main weights to be added too. Do not change the small ones, as they are of the proper weight to counter-balance the weight of the eccentric and the momentum of the valve gear.

Ball Inertia Governor—The weights on the Ball governor (American Ball Engine), Fig. 10, cannot be changed without drilling out or filling in with metal, but the spring is adjustable. In making a change, remove the weight from either one or both ends of the weight arm to increase the engine speed and add weight to decrease the speed. If the engine slows down below the rated speed with full load, add to the weights with increased tension on the spring.

Another design of Ball governor is shown in Fig. 11. Two springs are provided to prevent troublesome swaying characteristic of a single spring, when used, due to the centrifugal force and gravitation. These springs are convenient for slight adjustments for the differences in speed at the several points of cutoff. Should the speed slacken under load, decrease the tension on the spring *A* and increase the tension on the spring *B* so as to make the governor more nearly isochronous. If the action of the governor is unstable, decrease the tension on the spring *B* and increase that on the spring *A*. For slight changes in speed tighten or slacken the nut *C*. For a considerable change in speed it will be necessary to add to or take from the weights in the pocket *D* in the arm *E*.

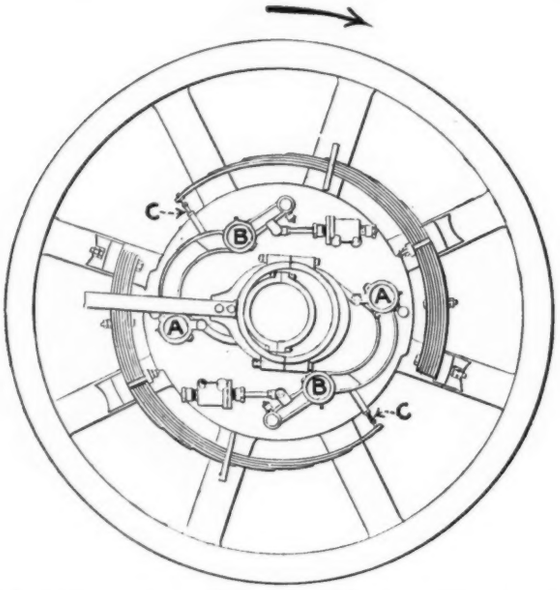


FIG. 15. McINTOSH & SEYMOUR GOVERNOR FOR SINGLE-VALVE ENGINES

Robb-Armstrong-Sweet Governor—In this design of governor, Fig. 12, a weight *A* is secured to the spring *B*. The tension of the spring is changed by taking up or slacking off on the tension studs *C*. The eccentric arm, which is pivoted at *E*, moves the eccentric pin, which changes the travel of the valve and also the point of cutoff.

If it is desired to increase the speed of the engine, put more tension on the spring; to decrease the speed of the engine put less tension on the spring. If closer regulation and more sensitiveness are wanted, move the pin *D* in the eccentric lever closer to the shaft center. To make more sluggish and prevent the tendency to race, move the pin *D* in the lever toward the rim of the wheel. There is no provision for changing the weight.

Begtrup Inertia Governor—This governor, used on the McEwen engine, has an inertia bar, pivoted at the center, and carries weights at both ends. A coil spring is attached to the wheel rim at one end and at the other to the inertia bar, as shown in Fig. 13. The weight of the spring end of the inertia bar is heavier than the other, and this weight *A* is so acted upon by centrifugal force that it tends to swing backward toward the stop *B*, but this tendency to move backward is counterbalanced by the spring, the tension of which is adjusted to hold the inertia bar in equilibrium at the desired speed.

The speed of rotation under a steady load depends upon the equilibrium between the centrifugal force acting upon the inertia bar and the tension of the governor spring, while the actual movement of the governor parts is effected by the inertia of the weighted end of the bar. If the weights on the inertia bar and the tension of the spring are so adjusted that the centrifugal force increases faster than the tension of the spring, the engine will speed up under load, and the engine will have a tendency to race. Racing is prevented, however, by the use of a dashpot. Thus the governor may be so adjusted that the engine will run faster under load than when running light and still regulate. The governor may also be adjusted to run the engine slower under load than with no load.

McIntosh & Seymour Governor—The governor for McIntosh & Seymour engines is made in two designs, one for large engines and one for single-valve engines. The governor for large engines is shown in Fig. 14. It is arranged to vary the speed of the engine by changing the spring tension and weight. On the large engine governors more weight in the weight arms gives less speed and less weight more speed. Sluggishness at a given speed is overcome by increasing the tension on the springs by adjusting the screws *A* and by adding weight at *B* and *C*. If the engine races at a given speed decrease the tension on the springs and reduce the weight.

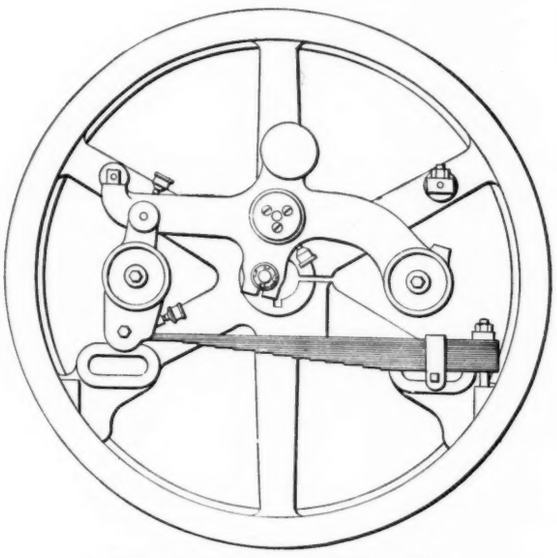


FIG. 16. SHEPHERD GOVERNOR

The governor for the single-valve engine, Fig. 15, is regulated in the same manner as the one shown in Fig. 14, but is different, as one weight exerts inertia force and one the centrifugal force. To produce more speed, give less weight alike to both arms at *A* and at

B. To get less speed, add equal weights. If the governor is sluggish at a given speed, increase the tension on the springs by means of the screws *C* and adjust the weights for less speed If the engine races, lessen the tension to the spring and take weights from the weight arms.

In altering the sensitiveness of the governor by changing the length of the governor springs, the speed of the engine will also be changed, and it should be brought to the desired speed by a proper change in the amount of weights. Changing the speed by changing the amount of weights practically does not affect the sensitiveness of the governor.

A dashpot is used to give stability to the governor, so that it can be adjusted to give close regulation without any tendency to race under a fluctuating load.

Shepherd Governor—The Shepherd governor, Fig. 16, has but three moving parts. The tension of the spring is always in one direction, and the speed of the engine is changed by adjusting the weights. To increase the speed, remove some of the weights but do not adjust the spring. To reduce the speed, add weights. The design of this governor is such that the engine speed can be increased or decreased about 0 per cent from normal by weight adjustment, and sti maintain the same degree of regulation.

Treating Ashes To Save Unburned Fuel*

In the United States the adoption of mechanical stokers has enabled low-priced screenings of high ash content to be used, so that even with relatively high percentages of combustible material remaining in the refuse, the loss in money is not excessive. If the price of screenings returns to the pre-war level, around $1 per ton, the process proposed here will probably not be especially interesting except where the freight charges are high. However, if the price of delivered coal continues high, such a process should result in considerable saving. The cost of continuous operation of such a refuse-treating plant should not exceed 75c. per ton of fuel recovered.

Washing tests made in the laboratory of the mining department of the University of Illinois show the possibility of recovering the unburned fuel by crushing the refuse to ⅜-in. ring size, washing on coal-washing tables and removing the slime from the washed product by a dewatering conveyor-elevator or a screen. The coal-washing table is a standard piece of coal-washery equipment, similar to the concentrating table commonly used in ore-dressing plants.

Two washing tests were made, one being with ⅜-in. mesh screenings from the general sample, and the other with the oversize crushed to pass a ¼-in. round-hole screen. Combining the results of these two tests gives the average results for the entire sample of refuse as received from the power house. The total combined yield of washed fuel was 20 per cent of the gross weight of refuse treated. The washed fuels had an ash content of 25.5 per cent and an average calorific value of 9,754 B.t.u. The heating value of the dry screenings ordinarily fired at the plant is about 10,000 to 11,000 B.t.u., and the ash content 18 to 22 per cent. At a great many plants the boiler-furnace refuse contains a larger percentage of recoverable fuel. Operation of a table washery on refuse such as is produced at this plant would result in the production of one ton of fuel from each five tons of refuse handled.

The equipment required for a simple plant of this size consists of a corrugated roll crusher to which the refuse is fed by a chute direct from the power plant. The crusher should be set to crush the refuse to about ⅜-in. maximum size. The crushed material is stored temporarily in a feeder hopper of about 5 tons capacity, from which it is fed to a washing table by a short screw conveyor. Two inclined dewatering drag conveyors elevate the recovered washed fuel and also the discard from collecting sumps to their respective storage bins, and at the same time remove the water and fine slime.

Operation of such a plant would require only a part of the time of one man, as a coal-washing table needs only occasional attention after it is started and properly adjusted. In most cases the freight charges on coal purchased to replace this recoverable unburned fuel would be more than sufficient to cover the cost of operation.

*From "The Recovery of Unburned Fuel From Boiler Furnace Refuse," Serial No. 2281, prepared by the United States Bureau of Mines in co-operation with the Engineering Experiment Station of the University of Illinois and the Illinois Geological Survey.

Advantage of Nitrogen in the Boiler Furnace

Recent developments seem to indicate that open-hearth steel furnaces will soon be using oxygen in place of air for combustion. This would undoubtedly shorten the melting period and give more economical operation.

In the boiler plant, although the same union of oxygen with the combustible in the fuel takes place, it would be very undesirable to introduce oxygen unmixed with the inert nitrogen. A pound of pure carbon in burning unites with 2.67 lb. of oxygen to give 3.67 lb. of gases and a total of 14,600 British thermal units is released. The heat contained in each pound of gas products would be approximately 4,000 B.t.u. If the specific heat of carbon dioxide is taken as 0.2, the temperature resulting from the combustion with no loss would be over 20,000 deg. F. This temperature is far above the melting point of either furnace walls or boiler plate. While this high temperature would increase the rate of heat absorption of the boiler, the temperature of the chimney gases would be high, since the small volume of highly heated gases would not be able to throw off as much heat as is possible with a larger volume of gases.

With air entering the furnace, instead of only 2.67 lb. of oxygen combining with the carbon we have 8.87 lb. of nitrogen carried along with the oxygen. The total weight of the gases then becomes 11.54 and the theoretical flame temperature is reduced to around 5,000 deg. The weight of the nitrogen mixed with the oxygen reduces the heat generated per pound of gases, thereby reducing the furnace temperature. The larger volume of temperature gases transmits the heat more efficiently to the boiler. The presence of the inert nitrogen is actually an advantage.

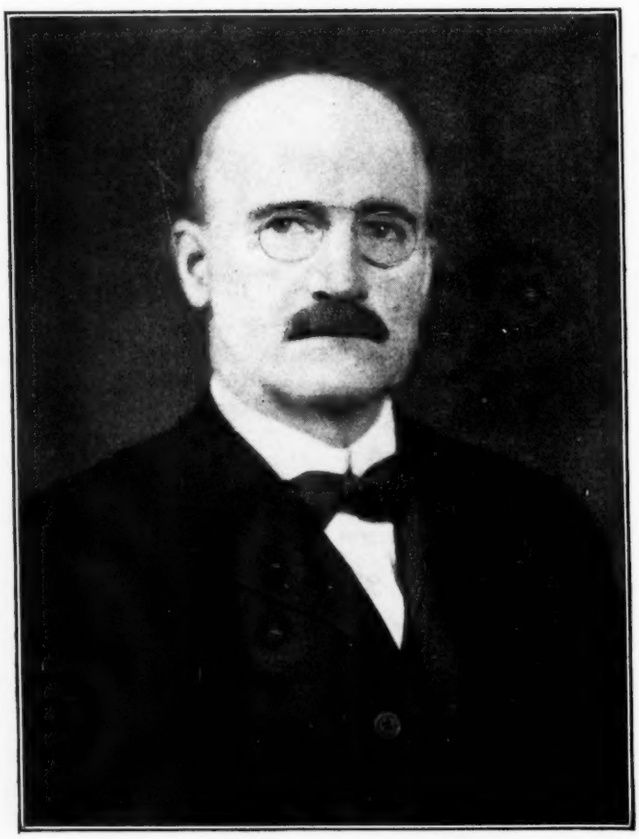
A Hydro-Electric Power State Board along the same lines as the Ontario Hydro-Electric Power Commission was recommended at the recent annual meeting of the California League of Municipalities through a resolution favoring the proposed initiative measure providing for the establishment of such a board in California. The sentiment of the meeting was quite generally in favor of municipal ownership and control of utilities.

Fred. N. Bushnell

A New England Engineer Who Has Designed and Built Many Power Plants

THE great development that has taken place in power-plant construction during the past third of a century is, in the main, the result of a long series of relatively small improvements.

Strikingly similar in its step-by-step advance and freedom from "flashes in the pan" has been the career of Fred. N. Bushnell, who started out 38 years ago as an apprentice in the shops of the Providence Steam Engine Co. and grew up with the power industry until he is now vice-president of a great engineering corporation and in charge of all its construction activities. Persistent, successful effort in his daily work combined with hard study and natural ability has brought him to his present position of responsibility in the Stone & Webster organization. Fred. N. Bushnell was born in Saybrook, Conn., May 15, 1867, the son of Richard W. and Sarah L. Bushnell. He received his education in Seabury Institute of that town and Morgan High School in Clinton, Conn. In 1883 he entered the employ of the Providence Steam Engine Co., Providence, R. I., as an apprentice, taking their regular four-year course in machine shop and drafting room. At the same time he continued his studies in accordance with a carefully worked-out plan for extending his education, particularly along engineering lines. These efforts attracted the attention of his employers, who gave him every encouragement and at the end of his apprenticeship course offered him a position as draftsman.



FRED. N. BUSHNELL

In 1889 Mr. Bushnell left the Providence Steam Engine Co. to enter the employ of Robert Wetherell & Co., where he was engaged principally in selling Corliss engines. After a year he returned to Providence as a superintendent with the Providence Steam Engine Co. There he saw the opportunity in the power field and decided to give up manufacturing in order to devote his energies to electric-power-station work. With this in view he resigned his position with the Providence Steam Engine Co. in 1893 to become chief engineer of the Narragansett Electric Lighting Co., of Providence.

While still acting as chief engineer of the latter company he became, in 1898, mechanical engineer for the Rhode Island Co., operating all the electric street railways in Providence, Pawtucket and adjoining towns. In 1902 he became chief engineer of this company. The work in this period of rapid development included power stations, transmission lines, track work, bridges, car barns and repair shops. During this time Mr. Bushnell designed and supervised the construction of the Manchester Street power station in Providence. His activities in power-station work attracted the attention of Stone & Webster, of Boston, and in 1907 he was invited to join their organization. His first work was to take charge of the design and construction of three power stations for the Boston Elevated Railway Co., which were the last of the large engine-driven plants to be built by this organization. In 1908 Mr. Bushnell became engineering manager and later manager of the Division of Construction and Engineering of Stone & Webster, Inc. The administrative work of the position includes the design and construction of water-power plants, gas plants, electric railways, transmission lines, substations and industrial plants of all kinds, as well as steam-power stations; but it is in steam-power station design and construction that Mr. Bushnell's professional work with Stone & Webster has found its chief expression. A large part of this work, amounting now to over 600,000 kw. of installations, has been done under his personal supervision. It includes such well-known plants as the South Boston power station of the Boston Elevated Railway Co. (80,000 kw.), River Station of the Buffalo General Electric Co. (95,000 kw.), Lowellville Station of the Mahoning & Shenango Railway and Light Co. at Youngstown, Ohio (45,000 kw.), Cannon Street Station of the New Bedford Gas and Edison Light Co. (72,000 kw.) and others. The great simplicity that has characterized the design of most of these power stations finds ultimate expression in the new South Meadow Station of the Hartford Electric Light Co., which will shortly be put into operation.

Mr. Bushnell joined the American Society of Mechanical Engineers in 1891, and was a manager of the society from 1916 to 1919. He is also a member of the American Society of Naval Engineers and the American Society for Testing Materials.

EDITORIALS

Seven Factors in Unemployment

SEVEN general remedies were offered by the Unemployment Conference as major means at hand to cure the basic causes of the present situation. Six of the seven do not deal with conditions of employment at all, but rather with those matters that contribute to items of "overhead costs," that group of intangible but very real expenses which are the dread of every operating department. The seventh, dealing with the subject of waste, falls directly within the field of operating control.

Two of the proposals deal with railway problems. The very first in order of mention, and apparently in order of importance in the minds of the Conference, is the adjustment of railroad rates to lower levels that will permit the flow of reasonable amounts of traffic over the rail systems of the country. This recommendation will be more than welcome to every user of fuel, for in no other line has the increase in freight tariffs been more burdensome than in the case of coal, a commodity that could ill stand the tremendous extra burden of higher rates. For long-run improvement of conditions the other railway problem, that of adjusting the Government indebtedness to the railroads, will be no less important.

Federal tax adjustment and the settlement of tariff laws are obvious causes of business uncertainty that receive their deserved attention in the report. These two matters have attained an importance in the everyday life of the community that could not have been foreseen even so recently as five years ago. To the management the extent to which each will be a factor in next year's costs is as important as are price of coal and boiler-room wages to the plant engineer. Without decision on each, costs can only be guessed, and when we guess at costs, it is not likely that we shall go forward most rapidly in the plans for next season. Facts are demanded; indeed, they are essential at once.

In the determination of Governmental costs there is no other factor comparable in magnitude with the question of the military expenditure. It is natural, therefore, that this subject is cited as one of the basic seven. The demand for a limitation of armament is thus again pointed out as one of direct concern to every individual, as in some measure determining whether he will be able to find a job. Whether we pay Federal taxes directly or not, we thus see our cause for concern that these be not unduly high.

With the large increase in scope and importance of foreign trade there has come to almost every industry increased need that every facility be afforded our export and import transactions. With wild fluctuation in exchange comes greatly increased hazard to this business, and one which it is not just now in position to stand without chances of serious curtailment of the business itself. Industrially, America is overbuilt. There is no use in winking at this unquestioned fact. We cannot consume that which we are prepared to manufacture in many, if not in most, important industries. If we are to put the equipment and trained personnel of these industries to work, we must sell abroad to some extent. To cut off such sales by continuance of hazards in the business will thus be of great concern and loss to all. It is thus more than of passing interest to know what is to be the value of the franc, the pound, the lira and the mark.

An Idea Worth Adopting

BACK in 1914 there was formed in Boston an organization called the Plant Engineers Club. The membership was limited to twenty-five plant engineers whose work was in or near Boston. In addition it was stipulated that no industry should be represented by more than one member. In this way there was formed a compact group of men whose common interest lay in the generation of power and more particularly the economical production of steam.

The avowed purpose of this organization was to get the members to "open up" and discuss their power problems frankly and freely. This object was achieved. The small size of the club was conducive to the active participation of all the members in the discussions. The "atmosphere" was so intimate that it was easy for the diffident to overcome their natural hesitancy about "speaking up in meeting." The distribution of members in various industries was also a distinct advantage because it assured a greater variety of ideas and experiences and hence a greater chance of each member learning something of value.

The representation of many industries in a single organization of this sort is without doubt decidedly beneficial to all concerned. On the other hand, it is debatable whether the limitation of membership to one man from each industry is, on the whole, desirable. This restriction apparently arose from a wish to defer to the age-old belief that it is dangerous to encourage free discussion between members of competing industrial organizations because valuable process secrets may thus become common property. Many practical men are now coming to feel that this danger has been greatly exaggerated for the simple reason that most manufacturing secrets are such only in the imagination of their protectors. It has been almost universal experience that the exchange of information not only between, but also within, industries has been decidedly beneficial to all concerned. In addition such an exchange is of great economic advantage to the whole country because it is the very foundation of industrial progress.

From the viewpoint of the power-plant engineer the limitation of membership to one man from each industry is unfortunate because it keeps out many good men. Even the formation of a number of similar clubs in each industrial center would not solve this difficulty, because such centers ordinarily concentrate on one or two industries.

Considerable stress has been laid on the only apparent defect in the organization of the Plant Engineers Club. In all other respects the plan seems to be an admirable one. It is certainly true that the club

has proved most beneficial to the members and their respective plants. This is due largely to the adoption of an idea whose development may now be traced.

One difficulty that hindered the successful work of the Plant Engineers Club in its early days lay in the fact that the members did not "speak a common language" when it came to comparing the day-in and day-out performance of their plants. No two of them kept the same kind of records; hence no reliable comparison of operating results was possible. To overcome this difficulty, the members co-operated in the preparation of a standard code for keeping records of operation. This code grew out of the combined experience and ideas of the whole group. Those members who lacked them installed whatever instruments were necessary for the records agreed upon.

The result was that each member was enabled to see where his plant was weak by comparing it with the others on a standardized basis. It became possible to make well-considered changes in equipment and methods of operation. Each member was served not only by his own records, which alone were well worth their small cost, but also by the records of the other twenty-four members.

The Plant Engineers Club is now in its seventh year, and the standardized record keeping has been going on five years with highly gratifying results. The idea is worth adopting. There seems to be no good reason why the various organizations interested in the economical production of power or steam should not agree upon a uniform code for recording the results of routine operation. The general adoption of such a code, carefully prepared to meet a wide variety of conditions, and frequent comparison of the results obtained, would tend to put isolated plants on a basis of friendly competition and thus raise the level of the whole industry. Operating engineers have nothing to lose and everything to gain by the experiment.

Simplified Electrical Connections

THE transition from what may be called steam-mechanical generation and transmission to steam-mechanical-electrical generation and electrical transmission of power has brought with it a large number of new devices, not alone on the steam end, but more particularly on the electrical end of the plant. Probably the chief worry of the predecessor of the modern power-plant engineer was that the steam pressure be maintained at normal value. In the modern alternating-current plant, in addition to the many intricacies that have developed in the steam end, there are the problems of synchronizing the various machines before connecting them in parallel, the maintaining of proper frequency, voltage, power factor, etc. To do this intelligently requires an intimate acquaintance of the equipment used to indicate these results. In this issue, beginning on page 625, there is an article on common types of alternating-current instruments, treating in particular the connections for synchroscopes, frequency, power-factor and reactive-factor meter. At first thought it might appear that the connections for these instruments are complicated, and probably this is true when the wiring to any one instrument on the switchboard is considered along with the wiring for all the other equipment, but when each individual instrument is isolated so that it can be studied by itself, the complications to a large degree disappear.

An examination of the diagrams in the article will show that, as far as connections are concerned, a power-factor or reactive-factor meter is only a frequency meter with a current coil added, the voltage coils of the former being connected as those of the latter. Furthermore, the simple connections for the synchroscope are the same as those for the power-factor meter. Although the synchroscope may be a different looking instrument from one for indicating power factor, looked at from the terminals they are similar, although in one the moving element is arranged to revolve, while in the other its movement is limited to part of a circle. After the connections are properly made, consideration must also be given to the relation of the currents in the various circuits in the instrument, or wrong reading may result. These can usually be checked by a few simple tests such as outlined in the article. Careful checking of instrument connections is very essential, since many an operator has fooled himself into thinking that high power factor or other desirable features of operation were being maintained, to find out later that the apparent results were due to wrong connections.

Desirability of High Power Factor

SOME apparatus or equipment is installed for a more or less temporary service, and the accomplishment of a given task is the sole end. The majority of equipment, however, enters into construction of a fairly permanent nature. The natural life of most power-plant and electrical machinery is of the general magnitude of fifteen years. Can the useful life be made to correspond with the natural life? In selecting machinery, it is common to consider only the conditions existing at the time of installation. Should it not be the endeavor to sense the trend of the times and to base the selection, at least to some extent, upon the probable conditions during the term of service contemplated? Such a policy might increase the term of service and also the value of the service rendered.

Pertinent to this thought is the fact that economical long-distance transmission of electric power requires a high power factor and that power factor must be corrected at load centers. This adds another argument to the desirability for high-power-factor load and should further increase the popularity of the synchronous motor. It is probable that, in years to come, low-power-factor loads will be penalized more severely than at present.

During the last few months a considerable number of accidents occurred in refrigerating plants. While none of these led to loss of life, the monetary loss was large enough to justify investigation as to means of avoidance of such accidents. The outstanding feature of most of these occurrences has been the apparent lack of information possessed by the operating force as to the proper steps to take to localize the damage. Ammonia is dangerous and the men at every refrigerating plant should be thoroughly drilled in "Safety First" methods. Such apparatus as safety helmets should be kept in an accessible place, and even the firemen shown how and where to close the valves cutting out the damaged portion of the plant. Lack of such preliminary training will quite likely lead to a heavy loss of life.

CORRESPONDENCE

Wanted, a Remedy for Static Electricity

I have an engine from the flywheel of which a 24-in. belt drives a lineshaft. At times there is considerable static electricity, which is annoying, and the problem is how to prevent it. Can any reader suggest a method that will do the trick?

Chelsea, Mass. C. N. PETERSON.

Is Scratching Sound Due to Faulty Lubrication?

Referring to the problem submitted by John S. Holmquist on page 460 of the Sept. 20 issue of *Power*, assuming that the engine in question is shaft-governed with automatic cutoff, the trouble has all the earmarks to me of a leaky steam valve and not faulty lubrication, as he says that he has tried several kinds of lubricant and flooded lubrication without success. A small steam leak will make just such a noise as he describes, and if the leak is into the exhaust passage it will cause a whistling sound in the exhaust pipe, if the engine exhausts into the atmosphere. We used to call them "canary birds" when on the testing floor in the shop.

I had a similar experience a good many years ago, and after all the remedies he describes had been tried without success, an exploration was made with mirrors and lights, and a minute blowhole was discovered in the valve chest. Plugging this hole with a piece of small copper wire stopped the noise. A scored valve-chest liner will also cause a similar sound.

As to his suggestion to change the lubricator connection to discharge the oil above the separator, it should not be done, as a large portion of the oil would pass out with the water trapped out of the separator. Most of the lubricators nowadays have faulty oil connections in that the pipe just goes through the wall of the steam pipe and the oil trickles down the wall of the pipe instead of being atomized by the steam, as it would be if the oil connection was long enough to reach about the middle of the steam pipe.

Philadelphia, Pa. ALONZO G. COLLINS.

Engineer or Engineman?

The editorial on page 547 of the Oct. 11 issue, "Engineer or Engineman," by F. R. Low, causes one to wonder just where the distinguishing point between an engineer and an engineman occurs.

In the larger plants of the country the men who handle the boiler furnaces are called firemen; those who look after the water, water tenders; ashes, ash handlers; coal, conveyor men; and the men who operate the engines, engineers. In a small plant the man who operates it fills all these duties and sometimes many others. He would stand near the foot of the line when compared with men who are engaged in larger plants and more responsible positions.

There are many fairly large power plants devoted to manufacturing, in which the man who has sole charge has not reached the dignity of master mechanic, superintendent of power, and the like, and yet he is a man who has brains, uses them and knows how to get his hands dirty. When an engine is disabled, he directs the repairs; when improvements are required, he often furnishes the data and superintends the work of installation. Such men have designed complete power plants, although they may be found about their plant the better part of the day. How do such men stand? Engineers or enginemen?

Because a man does not happen to occupy the padded chair in the chief engineer's office is no sign that he is not just as much an engineer. I know an engineer who is an assistant to the chief of a large office building. I know that he is a better-informed man than his chief and knows how to handle men as well. However, he spends his time in the engine and boiler rooms instead of before the office desk, and such a man would, I suppose, be called an engineman. He is, however, an engineer capable of working with his head as well as with his hands and is "skilled in the principle and practice of steam engineering." There are many more like him.

The man in the sawmill, small factory, power station, office building, and large central station, when does the one remain an engineman and the other an engineer?

New York City. E. L. JESSUP.

Engine Friction

The collection of data over a period of years pertaining to engine friction would seem to be of some value to readers of *Power* and three curves are shown, Fig. 1, being fairly representatives of engine friction, obtained from engines of 150 to 200 indicated horsepower. These curves indicate the friction horsepower as taken from new engines assembled for testing purposes at the factory before shipment. The friction is high because the bearings are not yet worn to a proper fit. This will be greatly reduced after a few months' operation as indicated by the curves, Figs. 2 and 3. In Fig. 1 the relation of friction is represented at the various fractional loads for simple single-valve engines, for tandem single-valve engines and for single-cylinder

four-valve engines. It will be seen that these three curves rapidly approach the vertical line where no power is delivered, and the indicated horsepower is all consumed in friction. The friction of the tandem engine becomes rapidly greater at the lighter loads. It is evident, therefore, that a tandem engine is very inefficient at light loads, because the percentage of friction becomes great. The four-valve engine shows greater friction than the single-valve engine, which

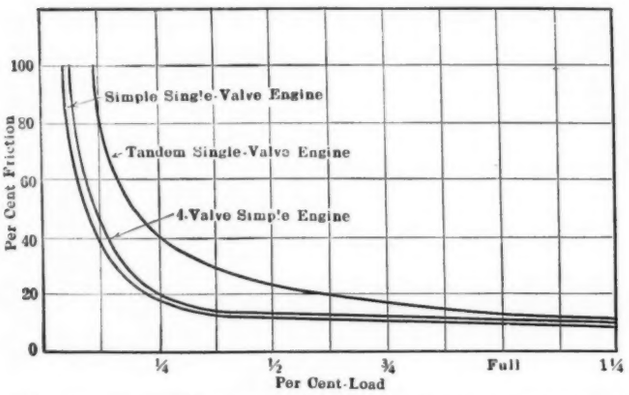


FIG. 1. FRICTION CURVES OF 150- TO 200-HP. ENGINES, BEFORE INSTALLATION

difference, although not great, becomes more pronounced at the light loads.

Referring to curves Fig. 2 and 3, the data shown are taken from a number of engines. The base line represents different sizes of engines, from 10-in. stroke to 28-in.; the vertical line represents indicated friction horsepower, and the percentage of friction. The percentage of friction means the percentage of full-load rating. It is evident, therefore, that small engines have a considerably greater friction in percentage of full-load rating than the large sizes. The friction horsepower before installation means that the data were taken from new engines when erected on the test floor for testing purposes before shipment. Indicating horsepower after

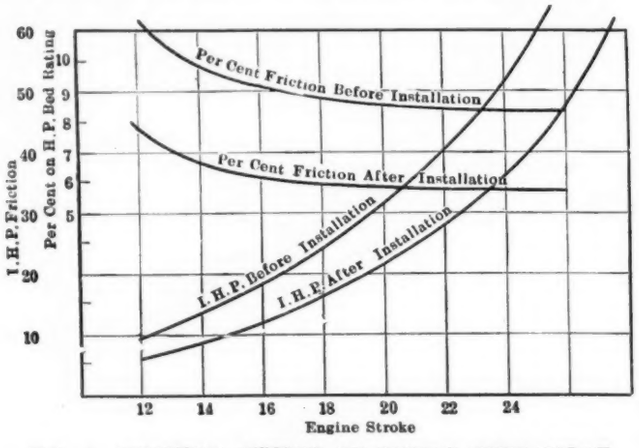


FIG. 2. FRICTION CURVES OF SIMPLE FOUR-VALVE ENGINES

installation and percentage of friction after installation means that these data were taken from engines that had been in service up to periods from one to two years.

Data shown by Fig. 3 pertain to single-valve engines of the side- and center-crank types, there being little difference in the friction between side- and center-crank construction. Data shown by Fig. 2 are taken from single-cylinder four-valve engines and are somewhat greater than those of single-valve engines.

It is interesting to note the very considerable reduction in friction after such engines have been in service

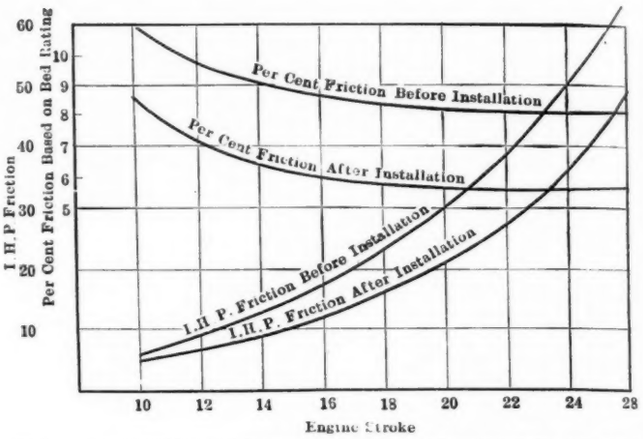


FIG. 3. FRICTION CURVES OF SIDE- AND CENTER-CRANK SINGLE-VALVE ENGINES

for a sufficient time to enable the bearings to wear in to a fit, and after they have been adjusted to satisfactory running conditions.

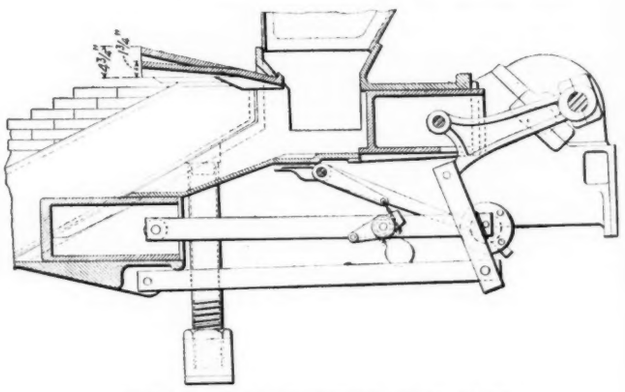
THOMAS HALL.

Harrisburg, Pa.

Lowered the Ram Caps

I read in the issue of Aug. 2 a report of the Prime Movers Committee in regard to erosion of the front walls of furnaces where underfeed stokers are used. We have overcome this in our plant by using low ram caps instead of placing 4-in. pipe in the front walls.

Referring to the illustration, it will be seen that the ram cap has been lowered from $4\frac{3}{4}$ in. to $1\frac{3}{4}$ in., the



FORMER AND PRESENT RAM CAPS

latter cap being made from our own pattern. As the coal feeds into the boiler, it becomes compacted and moves faster at this point, which eliminates the wiping of the wall and also prevents burning out the ram caps.

We adopted this idea about five years ago and are getting excellent results. It can be applied to almost any underfeed stoker. We would not do without the low ram caps; they last longer than the higher one, as they do not burn out so readily, and the front walls last twice as long.

J. S. MACHAMER.

Cuyahoga Falls, Ohio.

Taking Indicator Diagrams

In the Oct. 11 issue of *Power* P. A. Baumeister, in discussing indicator diagrams, makes several statements to which exceptions are taken.

In the diagram shown as Fig. 2 in the original discussion (here shown as Fig. 1) he states that the almost horizontal line at the beginning of the compression line is due to either a loose piston or play in the indicator motion. A few minutes' consideration will show that neither of these two things could possibly be at fault. If the indicator piston was a loose fit, the air would leak past the piston during the entire stroke. The compression line, instead of showing a sharp jump as in Fig. 1, would be smooth, but with an increasing falling away from the true compression line. The pressure at the end of the compression would be very low since with the increasing pressure more air would escape past the loose piston.

Slackness in play in the indicator pencil motion is not to blame. If any slackness existed, the pressure would move the piston up until the lost motion disappeared, whereupon the pencil would start making a smooth curve with no sharp jump as shown. Any of a number of defects could cause the distortion shown, but most of such indicator distortions are traceable to the sticking of the indicator piston, which prevents any motion of the pencil until the cylinder pressure overcomes the piston resistance, whereupon the piston moves up to its proper position, causing the pencil to trace an abrupt rise.

In explaining the cause of the distorted re-expansion line in Fig. 4 (here reproduced as Fig. 2) the statement was made that the hump in this line was caused by a stretching cord or a weak spring. The stretching of the indicator cord would not in any case cause the re-expansion line to curve to the right as shown. If the cord stretches as the piston moves downward on the suction stroke, the indicator drum does not move so far as it should to show the relative position of the

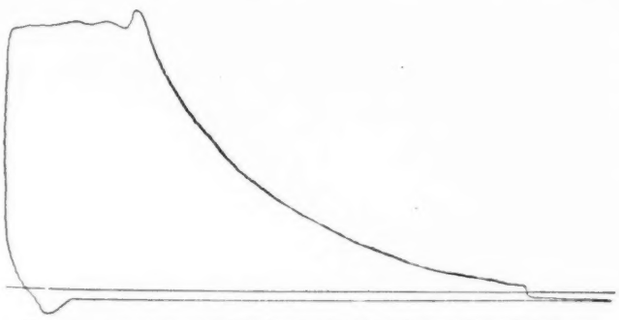


FIG. 1. DIAGRAM WITH A DISTORTED COMPRESSION CURVE

compressor piston. The indicator, then, for the pressure existing within the compressor cylinder at any point in the stroke, would show a smaller travel from the end of the stroke. The re-expansion would dip along a curve to the left of the real curve.

A weak piston spring could not cause the distortion. If the spring is weak, the pencil at any position of the compressor piston travel would show a higher pressure than actually existed. The discharge line would be higher and the re-expansion line would be higher, but would show a smooth curve since the spring error exists at all points in the diagram. The entire diagram would be raised in height, but no sharp distortion in the re-expansion line would be shown.

Without examination of the indicator and compressor, it is of course impossible to state the cause of this distortion. In many instances the compressor piston has proved to leak, and in other cases leakage of the dis-

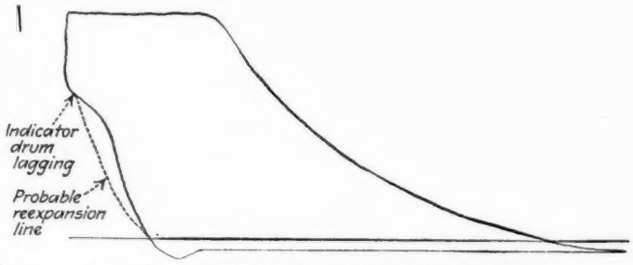


FIG. 2. DISTORTED RE-EXPANSION LINE

charge valves causes a somewhat similar curve. While using an indicator on one compressor, this kind of a re-expansion line was found to be due to corrosion in the indicator barrel.

J. CASSIDAY.

Jersey City, N. J.

Bearing Metals

The article regarding bronze for bearing metal, by E. T. Keenan, in the Aug. 20 issue of *Power*, prompts me to submit the following: The properties of bearing metals necessary for satisfactory service are such a combination of hardness and plasticity that it will withstand the pressures developed in the bearing without giving way or undue wear. If this pressure becomes so concentrated at one point that it will crush just sufficiently to redistribute the pressure without cutting or damaging the shaft, it follows that each class of service, depending on the average bearing pressure, whether intermittent or continuous and accompanied by impact or not, and the trueness of the bearing surfaces, will require a corresponding characteristic of bearing metal for the best results. The questions of radiation and conduction of heat into or out of the bearing and the proper running temperature must be arranged for by proper ventilation, by, at times water circulation or, best of all, the continuous supply of enough oil that will retain its proper body at the bearing temperature to lubricate the surfaces thoroughly and at the same time carry away the excess heat.

Modern practice inclines strongly to babbitted bearings, which have the advantage that when anything does go wrong and the bearing heats up unduly, only the babbitt is spoiled and the more expensive and less easily replaced shaft is not damaged to such an extent as to require re-turning.

The properties of any alloy for bearing purposes depend both on its composition and heat treatment to produce the proper crystallization of the constituents and their distribution with respect to the bearing surface to give the best resistance to pressure and wear. Microscopic examination of good bearing surfaces shows mosaic of harder crystalline particles embedded in a softer, more plastic medium, these taking the pressure and wear when the pressure on any one point becomes too intense, causing them to crush back slightly into the matrix.

The difference between a properly cast bushing and one made up from a piece of drawn rod or tubing may

be taken by analogy from the difference in bearing between the end and the side grain of timber, a matter that has long been recognized in the making of wood paving blocks. In the first the fibers all present their ends to the wear and are reduced evenly, maintaining a smooth surface, whereas the second is likely to splinter with the further disadvantage, in the case of a bearing, that these slivers have no place to go and therefore make trouble.

The original babbitt metal was mainly tin, hardened by copper and antimony. Various compositions are given due, possibly, to changes made by Babbitt himself for different purposes or variations in the foundry, but running tin 84 to 90 per cent, copper 4 to 8 per cent and antimony about 8 per cent. This is one of the best metals produced for heavy service, the tin providing an excellent crystalline structure that does not deteriorate in service, is hardened by the antimony and toughened by copper. Numerous other formulas containing lead, zinc and bismuth may be found in any reference book, but the average user will do better to purchase the grade of metal recommended by some reputable manufacturer and devote his full attention to carrying out the manufacturers' directions as to melting, protecting from the air, skimming and the pouring temperature to obtain the desired structure of the metal rather than worrying over small differences in composition.

In general, antimony acts as a hardener, copper both hardens and toughens the alloys, tin improves the grain, and zinc and lead act as fillers, although these characteristics are more or less relative and do not increase directly with the quantity added. Thus an excess of antimony—over 18 per cent—will cause brittleness when copper is present, but more can be used with lead alone. Tin and zinc also harden lead, but the alloys are likely to be brittle.

Among the brasses and bronzes there are five general types in commercial use, of which only the last two are satisfactory for bearings under conditions that provide any sort of test of bearing qualities. These are:

1. Ordinary low brass (low in copper) such as is used for plumbers' fittings, miscellaneous hardware, etc. This contains 30 to 40 per cent zinc, 60 to 70 per cent copper and, while strong, is hard and brittle and does not have the structure desirable in a good bearing metal.

2. High-strength rod brass alloys. Typical of these are muntz metal, tobin bronze, manganese bronze and delta metal, all containing a little iron and traces of tin and lead in addition to about 40 per cent zinc and 60 per cent copper. These alloys may be forged at a red heat, but they are not easy to cast successfully, as the iron seems to be retained in the alloy only with difficulty.

3. Tin bronzes contain approximately 85 to 90 per cent copper and 15 to 10 per cent tin. Owing to the solubility of copper oxide in melted copper, it is only by the use of aluminum or phosphorus as a deoxidizer that these alloys can be cast soundly in ordinary commercial practice, and the most commonly known alloy of this class is therefore called phosphor bronze. These alloys have too great compressive strength to make good bearing metals and they show a tendency to heat with shafts slightly out of true.

4. Copper-zinc-tin alloys, usually called composition. These are the most important in cast alloys, as by the variations of zinc and tin almost any hardness and ductility desired can be obtained. Copper in these alloys is usually between 80 and 88 per cent, but almost all combinations of tin and zinc are found. One of the most generally satisfactory for strength and ductility is U. S. Government composition of copper 88, tin 10, zinc 2 per cent, as it gives excellent sound casting of good grain. Alloys higher in zinc are harder and more brittle, those higher in tin more ductile and somewhat weaker. For bearings from these alloys the metal should be cast nearly of the form desired, for bushings, around a core, at times with a chill inside to insure prompt setting and in this way close grain at the surface.

5. Compositions containing lead. Part of the zinc or tin in the foregoing alloys may be replaced by lead, resulting in a somewhat softer casting, easier to machine and of closer grain. There was a decided prejudice against bearings containing lead, but for modern foundry methods it seems to give satisfactory service. In fact, where castings are required to be water-tight, such as cored shells, 3 to 5 per cent lead will do much to insure soundness in small castings. The great trouble is that lead is cheap and there is too much temptation to substitute it for the more expensive tin.

In general the proportions of bearings and the choice of materials are pretty well understood, so that where trouble due to heating or too rapid wear occurs, the engineer in charge should be sure that the cleanliness and lubrication of the bearing has not been neglected before condemning its design and material.

New Haven, Conn. H. D. FISHER.

Emptying Oil Barrels by Compressed Air

A letter in a recent issue of *Power* describing a device for emptying barrels of oil by the compressed-air process, interested me, as I have used this method for many years. One writer warns of the danger of getting too much pressure on the barrel. I found by experiment that with 4 lb. pressure a barrel of engine oil could be emptied in seven minutes, forcing the oil to an elevation of eight feet.

A dead-weight safety valve was made by turning the threads off the stem of a ¾-in. angle valve and securing sufficient weight to the valve wheel to balance a 4-lb. pressure. This valve was placed in the air line between the barrel and the air-supply valve, which, for ease of control, should be not larger than ¼-in. If for any reason the oil did not flow readily from the barrel, the safety valve prevented the pressure building up. The small opening of a ¼-in. valve will be sufficient to elevate the oil rapidly.

In elevating cylinder oil in cold weather, I stand the barrel in a warm place for two or three days before unloading to get the oil more limpid. It usually takes from 30 to 40 minutes to empty a barrel of average cylinder oil.

The ordinary oil barrel will safely withstand 4 lb. pressure, and after a little experimenting with the amount of opening necessary to give the air-supply valve, one can connect up the apparatus, turn on the air and go about other work without any danger of a burst barrel. When the oil is all out of the barrel, the slight blow of air through the discharge pipe will indicate it, and no damage will be done if no one is near to shut off the air. C. A. GREEN.

Cleveland, Ohio.

QUESTIONS AND ANSWERS

Coal per Kilowatt-Hour

In a statement of plant economy expressed in coal per kilowatt-hour, what factors are taken into account? R. B. C.

When not otherwise specified, the coal per kilowatt-hour used by a plant is understood to be the gross number of pounds of coal used by the plant divided by the net kilowatt-hour output of the plant during the same period. To arrive at the net output delivered to main feeders, the power required for the auxiliaries of the plant itself should be deducted from the gross output of the generators.

Cast Iron as a Material for Boiler-Heating Surfaces

Why is cast iron considered to be unsuitable for heating surfaces of power boilers? C. E.

Cast iron will transmit the heat of furnace gases nearly as efficiently as wrought iron or steel of the same smoothness and thickness, the lower efficiency being due to less solidity of material. But on account of the uncertainty of soundness and thickness of castings, and strains introduced by unequal cooling, the strength of the material is unreliable for high pressures even when high factors of safety are intended. By repeated alternations of expansion and contraction from changes of temperature, the granular structure loses cohesiveness and sudden changes of the surface temperature are productive of hair-line cracks that sooner or later extend clear through the casting.

Flat Spots on Commutators

One of our generators has been giving trouble by flat spots forming on the commutator. The commutator has been cleaned up several times, but these spots come back repeatedly and cause sparking. Before having the commutator turned up how can I locate the seat of the trouble and apply the necessary remedy? B. L. M.

This trouble may be the result of a number of different causes. It may have been first started by the commutator being struck with some heavy object, causing a flat spot and sparking at this locality. Cleaning up the surface with sandpaper gives only temporary relief, since the slight sparking that occurs, soon aggravates conditions and the old trouble returns. High bars or low bars, or high mica will also result in flat spots. These spots sometimes develop at equally spaced points around the commutators. This may be due to one flat spot getting in bad condition and producing a high resistance at this location, so that when it passes under a brush a momentary rush of current is caused to flow through all other brushes of the same polarity. These spots may also be caused by an unbalanced armature winding producing a short-circuit current when this section passes a brush; mechanical vibration due to the armature being out of balance; or pounding of a direct-connected engine may cause this trouble. An eccentric commutator on a high-speed machine will throw the brushes when the high side comes under them and cause a flat spot. In some cases it has been found that the bars in one section of the commutator are harder than in another and resulted in flat spots on the commutator's surface.

Difference Between Vacuum and Discharge Temperatures

In condenser practice what is considered proper temperature difference between temperature of the condensed steam and the vacuum temperature and temperature of the hotwell and temperature due to the vacuum; and in Leblanc condenser practice what is the relation between vacuum temperature and the temperature of condenser discharge? W. C. A.

In the ordinary condenser the temperature of the condensed steam will be 10 to 20 degrees lower than the temperature corresponding with the degree of vacuum in the condenser. In surface-condenser practice the temperature of the condensing water at the discharge point will be 5 to 10 degrees lower than the temperature due to the vacuum. In Leblanc condenser practice the difference between vacuum and discharge temperature varies from about 3.5 deg. F. for 95 per cent capacity with 71 deg. F. of injection water and 28 in. vacuum to about 6 deg. F. for 45 per cent capacity and 28.75 in. vacuum.

Power in Gas-Engine Cylinders

It has been a question for discussion between the chief engineer and assistants of our plant, as to the amount of work done by the different cylinders of our 21 x 30 horizontal twin tandem gas engine. Some argue that the cylinders farthest away from the crank under the same conditions, with reference to the amount of fuel, timing and amount of lift of valves, and point of ignition, will do more work than the cylinders next to the crank. There are two double-acting cylinders on each engine, and there is a direct-connected compressor connected to the tail rod of each engine. We have not as yet found an authentic rule or theory for any of the arguments that have been advanced. What is the answer, J. K. B.

If these engines are fitted with tail rods, there is no constructional reason why the power in each cylinder should not be the same. Often the location of the exhaust line places a different back pressure on the several

cylinders. If the gas line is nearer to one cylinder, it is possible that the reduced frictional resistance allows more gas to enter this cylinder. A slight difference in ignition timing would also have an effect, as would a variation in the timing of the other valves. If the piston cooling in one cylinder is defective, a decrease in power might occur. Any difference in horsepower can be detected by using an indicator on each cylinder.

Weldless Diagonal Boiler Braces

What are the leading forms of diagonal stays used in modern boiler construction; and why are they better than the old forms made of round or square iron. L. H.

Modern boiler braces usually are made weldless, of flat iron, with the crowfeet made by bending the same piece of iron as that which forms the body of the brace, and therefore they are more reliable than braces made with crowfeet welded to the body of the brace. The three types of weldless diagonal braces most commonly used are known as the Scully, the Huston and the McGregor braces.

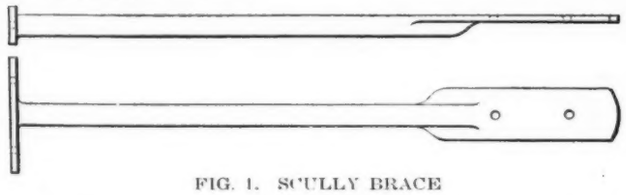


FIG. 1. SCULLY BRACE

The Scully brace, shown by Fig. 1, is made from one piece of soft steel pressed to shape in a forging machine, without welds.

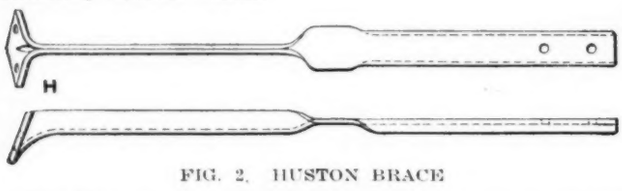


FIG. 2. HUSTON BRACE

The Huston brace, shown by Fig 2, is made of folded weldless steel plate. The head end *H* is reinforced by fillets and the shell end is stiffened by raised ribs.

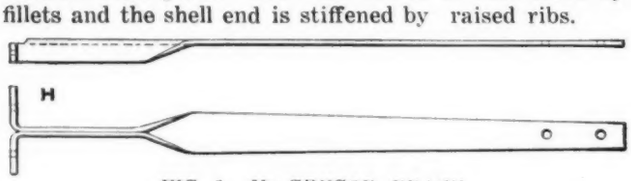


FIG. 3. Mc GREGOR BRACE

The McGregor brace, shown by Fig. 3, is made of folded steel plate, with the material at the head end *H* split and bent to a T-shape.

Annual Coal Saving by Pipe Covering

What would be the annual saving of coal by covering an 8-in. steam pipe 100 ft. long, containing steam at 5 lb. pressure with the pipe surrounded by air at the temperature of 50 deg. F. during 24 hours per day? T. P. S.

The amount of coal required to generate the heat radiated from the pipe bare or covered would depend on the quality of the coal, the perfection of the combustion and the efficiency of the boiler in securing transmission of the furnace heat to the water in the boiler. Assuming that the coal contains 13,000 B.t.u. per pound and the combined furnace and boiler efficiency is 60 per cent (which conditions are the average in practice for continuous operation of return-tubular boilers with fair firing and average coal), the loss by radiation from 100 ft. of bare 8-in. pipe containing steam at 5 lb. gage and surrounded by quiet atmospheric air at 50 deg. F. for 24 hours per day would be about 50 tons (each 2,000 lb.) of coal per annum. Having the pipe covered with 1¼ in. thickness of high-grade pipe covering, the loss of heat would be approximately 20 per cent as much and the saving would be about 80 per cent of 50 = 40 tons of coal per annum.

Computing Discharge from Valve Opening

What is the formula for determining the quantity of oil discharged through a valve in an oil line with various amounts of valve openings? F. R. M.

No general formula can be given for rate of flow of water, oil or liquids for various pressures when a valve is open ¼ to ¾ in., or wide open. Flow takes place as a result of difference of pressure on opposite sides of the valve and the amount flowing for various differences of pressure must be determined for each valve in its particular position in a line and for different amounts of opening. The flow taking place with any given valve opening and given difference of pressure can be ascertained by referring to a set of curves, each platted to show the flow for various differences of pressures with a given valve opening; or from a set of curves each showing the flow for different valve openings with a given difference of pressure.

An approximate method of metering the flow would be to put a counter on the pump to determine the number of revolutions during a given time and from that compute the discharge per 100 or 1,000 revolutions based on actual test of the pump when working at normal speed against various head pressures.

Factor of Safety for a Stated Pressure

If a horizontal return-tubular boiler that is 72 in. in diameter and made of ⅝ in. steel plate of 54,000 lb. tensile strength has a horizontal seam of 66 per cent efficiency, what would be the factor of safety when the boiler carries a pressure of 80 lb. gage? M. J. M.

The formula for the maximum allowable pressure on the shell of a boiler is computed from the formula,

$$P = \frac{TS \times t \times E}{R \times FS}$$

in which

P = Maximum allowable working pressure, pounds per square inch;
TS = Tensile strength of shell plates, pounds per square inch of cross-section;
t = Thickness of shell plates, inches;
E = Percentage of efficiency of the longitudinal joint;
R = Radius of the shell, inches;
FS = Factor of safety.

Substituting the given values, the formula becomes

$$80 = \frac{54{,}000 \times \frac{5}{16} \times 0.66}{(72 \div 2) \times FS}$$

hence

$$80 \times (72 \div 2) \times FS = 54{,}000 \times \tfrac{5}{16} \times 0.66, \text{ or}$$

$$FS = \frac{54{,}000 \times \frac{5}{16} \times 0.66}{80 \times (72 \div 2)} = 3.8$$

The Lubrication of Prime Movers

On Wednesday, Oct. 5, the System Operators' Association of New England met at Sterling Inn, near Worcester, Mass., and listened to a talk, illustrated by lantern slides, by Charles H. Bromley, technical director of the Richardson-Phenix Co. The meeting was well attended and presided over by the president, P. J. Kent, chief service operator of the Boston Edison Co. Mr. Bromley's talk, in abstract, follows:

Of all prime movers the steam turbine presents the severest condition for the lubricant. The journal speeds are higher than in any other class of machinery; the bearing pressures are relatively low, yet they are great and becoming greater; the temperature, particularly of the bearing adjacent the high-pressure end, also the thrust bearing, is extremely high, even normally. Total steam temperatures at the throttle of between 600 and 700 deg. F. are becoming common. Heat at this temperature is conducted to these bearings in addition to the heat of friction generated in the bearing itself. The oil circulates to the bearings rapidly—from 7 to 40 times per hour.

With these conditions to be met, the lubricating system must function so that at no time, not for a fraction of a second, shall there be metallic contact or metallic friction between the journal and the bearing shell. I know of no case where metallic friction has occurred that severe damage to the turbine did not result. The oil pressure varies from 2 to 15 lb.; usual oil temperatures are between 130 deg. F. and 180 deg. F. Thrust-bearing temperature is usually 20 deg F. higher than that of other bearings, except the high-pressure end bearing.

Oils for Steam Turbines

Our experience, as well as that of others, shows that for steam turbines nothing but a straight-run mineral oil will do. It must not be compounded or blended with any products not derived from crude petroleum. There should be no animal or vegetable fats in it. Water will get into the lubricating oil in a steam turbine, however careful the design and machinery of the unit, and however cautious the operator. And oil containing animal fats will emulsify and form sludge so badly as to be dangerous. The Prime Movers Committee of the N. E. L. A. in its 1921 report, page 6, well states it as follows: "Compounded oils are not to be considered, as turbine oils should be strictly pure, neutral mineral oils, without any admixture of animal or vegetable fats." The flash point, open cup, should not be lower than 315 deg. F. for extra-light oil to 335 deg. F. for medium. High flash point is desirable as it indicates slow evaporation and ability to retain original viscosity, provided also that the oil is slow to oxidize.

There is still much to learn about viscosity for turbine oils. However, the safe guide limits now are 110 sec. to 350 sec. Saybolt at 100 deg. F. The higher the speed the lower the viscosity may be. I have heard of excellent results with oil of 80 sec. viscosity. While this may be "sliding on pretty thin oil," to paraphrase an old expression, it is probable that we will eventually discover that there is no need for as much apprehension about thin oil for turbines as is now general. What chiefly concerns us is the viscosity at normal operating temperatures, and the ability of the oil to retain its viscosity throughout a long period of service.

Emulsion and Sludge

Emulsion and sludge form one of the chief worries of the turbine operator. If allowed to accumulate, they make impossible safe operation of the turbine.

An emulsion is a mixture of liquids, insoluble in one another, where one is suspended in the form of minute globules; also it is a mixture in which air and solid particles, or both, are suspended in a liquid. The turbine oiling system is practically ideal for promoting the formation of emulsion. Water and moisture will get into the oil from leaky shaft glands, leaky oil-cooler coils, and bearing cooling coils where water-cooled, also from the atmosphere. The churning to which the oil and water are subjected in the circulating system forms an emulsion wherein the particles are very finely divided. Obviously, the pressure oil film in the bearings will be seriously impaired by such an emulsion, and the risk of serious damage to the turbine will be imminent.

Sludge is that mucky, brown-blackish substance one finds in the turbine-oil reservoir, oil cooler and oil piping. It is the result of oxidation of the oil. If emulsion is allowed to accumulate, it soon results in sludge. The unsaturated compounds in the oil are more rapidly oxidized, and the metallic particles, dirt, dust, etc., apparently act as catalytic agents, for the formation of sludge increases at an accelerating rate with the formation of organic acids.

Standard of Demulsibility

It is up to turbine operators to demand the adoption by engineering societies of some workable standard of demulsibility for turbine lubricating oils. The term "good" demulsibility means nothing to an engineer, yet that is about all the information generally available.

Here is a way to make the Bureau of Standards test for demulsibility that is practicable: Apparatus necessary—a malted-milk mixer such as used at soda fountains, a thermometer, a 100-c.c. graduated vial, and an electric hot-point or other means of heating the sample. Mix 40 c.c. of water at 55 deg. C. (132 deg. F.) with 20 c.c. of oil. Keep the mixture at 55 deg. C. and emulsify in the mixer for five minutes. The number of cubic centimeters of water that settles out in one minute multiplied by 60 (the number of minutes in one hour) equals the standard demulsibility number for the oil. The perfect number is 1,200, being 20, the total water volume, multiplied by 60, the total number of minutes in one hour.

Where the oil is continuously kept clean, as in the continuous bypass system, the acid content seldom, if ever, gets over 1 per cent even after years of service of the oil. In fact, analyses have shown less acidity after two years continuous use of oil purified by the continuous bypass system than the oil contained originally. The explanation probably is that the acid is entrapped in impurities in the oil, and the continuous removal of these keeps down the acid content.

Methods of Maintaining the Quality of Turbine Oil in Service

We may disregard sweetening and merely adding make-up oil, because in modern practice, particularly with turbines of from 700 kw. capacity upward, no one would think of trying to keep the oil in good condition by such means. To attempt to do so is to fail because one merely dilutes the impurities; they are not removed.

Batch filtration was universally practiced until a few years ago, or until the advent of the continuous bypass system. Batch filtration was a decided improvement over sweetening, but it has several objectionable features. The entire oil charge is drained at intervals—when, rests entirely upon the operator's judgment and upon circumstances which may delay the cleansing of the oil until long after it should have been done. The quantity of oil in reserve must be large. The really serious objection is that batch filtration does not prevent the accummulation of emulsion and sludge.

When considering turbine-oil purification, the average engineer thinks of oil loaded with emulsion, muck and sludge. He must see it differently, for with modern means available the oil never gets unfit provided the right oil has been selected, the oil reservoir and piping are clean to start with, and water and steam leakage from shaft glands, cooler and other sources are kept down, as they can and should be.

This system of purification, adopted as standard by one large builder of turbines and highly endorsed by all other turbine builders and leading oil companies, consists of a

sight overflow, a filter, an oil pump and the necessary piping. The vented sight overflow is connected directly to the turbine-oil reservoir so that its overflow level corresponds with the desired oil level in the reservoir. The outflow of oil from the reservoir is automatically controlled by and is equivalent to the amount of oil delivered by the filter pump from the filter to the reservoir. Should this pump stop for any reason, the turbine continues to operate as though no system were installed, as this system is entirely independent of the self-contained oiling system of the turbine furnished by its builder. It is plain that a certain percentage of the total oil charge is passed through the filter per hour and that purification of the whole charge is continuous. Emulsion and sludge cannot accumulate as they are removed as fast as formed. At first one is likely to say that with this system clean oil from the filter is put into the dirty oil in the reservoir. The answer is that with this system there is no dirty oil either in the turbine reservoir or the filter.

Diesel-Engine Lubrication

Diesel-engine cylinders cannot be successfully lubricated by methods satisfactory for steam or air engines. Unless application of the lubricating oil is timed for a particular part of a particular stroke, there is every likelihood that, without extravagant use of oil, the lubricant will be burned away before it has time to function as a lubricant.

In the practice of one of the leading Diesel-engine builders the oil is delivered to the piston through the cylinder wall at two places 180 deg. apart. For the piston pins the oil is fed through the cylinder wall into a slot in the piston which comes even with the oil hole when the piston is on its lower center.

The lubricator uses alternate forcing plungers on opposite sides of the gear or plunger-actuating shaft; thus any two adjacent plungers force oil when 180 deg. apart. By arranging the feeds in groups each group on a separate gear shaft, and the shafts driven through gears or eccentrics or chains from the engine, any desired timing of delivery may be had. Ordinarily, the lubricator has a layshaft and three eccentrics set 120 deg. apart; the lubricator gear shaft is so divided that eighteen feeds are driven in sets of six to each eccentric, and of these six feeds three plungers are on one side of the gear shaft and three on the other. The lubricator has a divided oil tank to permit of using a different oil for the air compressor of the engine.

The oil is delivered among the piston rings on the lower center at the end of the power stroke. This insures thorough coating of the cylinder wall before the power stroke, during which the cylinder temperature is greatly increased owing to combustion.

Usually the crankpins and main bearings are lubricated by a gravity system which supplies the oil through gang sight-feed oilers, located on the engine frame columns.

A leading builder uses two feeds for each main bearing and one feed for the centrifugal oiler for each crankpin. All oil fed to these bearings and to the piston pins is caught in the engine base. One end of a small double pump delivers the oil to a filter conveniently located, the other end taking it from the clean-oil compartment of the filter and delivering it to a tank at such elevation as to give the desired pressure at the sight-feed gang oilers feeding the bearings.

Camshaft rollers are grease lubricated by hand-operated cups, and valve tappets and rockers by oil from a squirt can. These could be automatically lubricated like the rest of the unit, but is purposely not done so to insure attention and watchfulness on the part of the operator.

Practice in Marine Diesel Engines

In marine practice practically the entire engine is force-feed lubricated at low pressure. A tank in the ship's double bottom holds the oil supply. A circulating pump discharges into a cooler and then into a main parallel with the engine bed; branches from the main supply each main bearing and the thrust bearing. Holes in the crankshaft register with circumferential grooves in the main-bearing shells and feed oil to crankpins and piston pins.

The usual precautions are, of course, necessary to prevent leakage of salt water into the oil reservoir or sump and into the oil supply from the cooler. Where pistons are oil-cooled and the crankpins and piston pins are supplied with oil through holes in the crankshaft and connecting rods, trouble is likely to arise, owing to carbonized oil flaking off and clogging the oil passages.

These engines are, of course, tightly inclosed and bearings cannot be felt for temperature. A thermometer in the oil return pipe will indicate a serious temperature rise, but will not indicate the bearing affected. Various jim-cracks to indicate such have not been very successful. Care is therefore necessary in adjusting bearing clearances and keeping the oil, oil tank, and passages clean.

Reclamation of Internal-Combustion Engine Lubricating Oil

Naturally, because of the high temperature, considerable carbon is formed. When the oil is too heavily loaded with it, the carbon must be removed. This carbon is extremely fine. Filtration alone or centrifugal separator alone does not remove it as satisfactorily. The best results are obtained by the use of the reclaimer.

This reclaimer is in the form of a cylindrical shell. The dirty oil is heated by steam at 212 deg. or higher to bring about a satisfactory difference in the specific gravities of oil and foreign particles and water. After the heating period a coagulent is mixed with the oil and the mixture allowed to settle. Usually, a batch of oil is reclaimed every twenty hours. After settling is completed, it is best to allow the oil to run through a filter, which is readily attached to the reclaimer. These reclaimers are built with electric heating elements where steam is not conveniently available.

Boston Section of A. S. M. E. Discusses Standard Operating Code

With Professor Norton as chairman, the Boston Section of the A S. M. E. held a meeting in the assembly hall of the Engineers Club on the evening of Oct. 10. The paper of the evening was given by F. M. Gibson, plant engineer of the American Sugar Refining Co., whose subject was "A Uniform Code for the Continuous Operation of Boiler Plants."

Mr. Gibson, who is also president of the Plant Engineers Club, told of the adoption and successful application, by the members of that organization, of a uniform code for recording the data obtained in the routine operation of a boiler plant. The manner in which this code was developed and applied to meet the needs of the Plant Engineers Club is described in the Editorial Section of this issue of *Power* as well as in the following brief outline of Mr. Gibson's paper:

The Plant Engineers Club was organized seven years ago for the purpose of exchanging information on boiler-plant operation. The membership was limited to twenty-five plant engineers in or near Boston, with the further restriction that no two members could be from the same industry. In the early days of the club the free exchange and comparison of operating results was greatly hindered by the fact that the members did not "speak a common language." Each had his own particular method of keeping his operating records. Since no two kept exactly the same kind of records, it was difficult to make comparisons of any value. Finally, the members of the club prepared and adopted, each for actual use in his own plant, a standard code. This was such as practically to put the boiler-plants concerned on the basis of a continuous test.

The adoption of this code proved to be of great value to the members, who were then able to see at once just where their own plants were below normal and to benefit freely by the costly experiences of fellow members. One case was cited in which the cost of producing one thousand pounds of steam was reduced more than 30 per cent in the second month of record keeping.

The information called for by the code is extensive, and comes under the following general divisions: (A) General Data and Ratios; (B) Operating Conditions—Temperatures, Pressures, etc.; (C) Repairs Record (Detailed); (D) Boiler-Room Operating Costs—Direct Labor and Material Only (Detailed); (E) Supervision, Indirect Expense and Overhead; (F) Boiler-Room Fixed Charges—Depreciation, Insurance, Interest, etc.

Various partial totals are included in the record form. It was found, on account of the wide variation in the fixed charges, that the figure for total power cost with the fixed charges subtracted was the most useful in comparing the results obtained by the various plants.

In closing, Mr. Gibson suggested that the results of routine operation were of far greater significance than the results of short tests made, ordinarily, under highly artificial conditions. He stated as the opinion of the Plant Engineers Club that the general adoption of a standard code for continuous operation would be of great benefit to the power industry. Mr. Gibson's paper was followed by considerable discussion, most of it favorable to the code.

The A. S. M. E. Elevator Safey Code

While the boiler code of the American Society of Mechanical Engineers is well known and is becoming quite generally recognized, very little has been heard about a later work of a similar nature, the Elevator Safety Code, which was finally completed and approved by the society's council in January, 1921. After considerable delay, due principally to difficulties with printers, the code has been printed in pamphlet form and may be obtained from the Society Headquarters, at 29 East 39th St., New York City, for 65c. The society, of course, has no authority to enforce the provisions of the code, but simply presents it as a group of standards which its research work has shown to be desirable and dependable.

The elevator code embodies standards for the construction, operation and maintenance of practically all types of elevator equipment, and is divided into the following sections: Hoistway construction for passenger and freight elevators and for dumbwaiters; power passenger elevators; power freight elevators; hand elevators and hand invalid lifts; dumbwaiters; escalators; operating rules.

The committee that had charge of the preparation of the code is known as the Committee on the Protection of Industrial Workers and comprises the following: John W. Upp, chairman; Magnus W. Alexander, Carl B. Auel, William P. Eales, Carl M. Hansen, John Price Jackson, Byron Cummings, Melville W. Mix, William A. Viall, and Herbert L. Whittemore. Aiding in the preparation of the code were representatives of the United States Bureau of Standards, Elevator Manufacturers' Association of the United States, Elevator Manufacturers' Association of New York, casualty and fire insurance companies, American Institute of Architects, various related engineering societies, elevator specialty manufacturers and independent engineers. Prof. Clifford B. LePage, of Stevens Institute, is secretary of the committee.

According to a statement from the A. S. M. E., the code is now being considered in the states of California, Texas, Ohio, Maryland and Massachusetts, with a view toward adopting it as a permanent part of their laws. As a further indication of the respect in which the code is held, it is pointed out by the society that the Bureau of Standards voluntarily discontinued work that it had been doing along the same lines and co-operated with the society's committee in the preparation of the code that they were working on. With that object in view, H. L. Whittemore, one of the bureau's engineers, was appointed a member of the A. S. M. E. committee.

News in the Field of Power

"Malignant Combinations"

The Federal Trade Commission has sent out a statement that is particularly interesting at this time in view of the recent statement of President Harding's unemployment conference that high costs due to "malignant combinations" are strangling home building in this country.

The commission sent out 2,750 questionnaires to trade associations and replies were received from 1,773. According to the information supplied by the associations, there were 141 out of the total of 1,773, which distributed or exchanged information regarding prices in closed transactions. Nine associations indicated that they had recently discontinued the collection and exchange of information regarding their selling prices pending the decision of the United States Supreme Court in the Hardwood case. It appears probable that a number of others that formerly used open price methods had taken similar action.

The associations exchanging price information among their members were largely manufacturers and wholesalers, and they covered a very wide range of products. In most cases the price information was distributed among the members at frequent intervals; that is, daily, weekly and monthly, depending largely on the character of the business.

The information most commonly distributed by the associations not exchanging price information included statistics of stocks on hand, quantities produced, orders received and orders on hand.

Friction Drive Society Formed

A new engineering society, having for its object the collection and co-ordination of data on friction-drive engineering, was organized at a meeting Sept. 29 in Newark, N. J. It was the sentiment of the meeting that the subject of friction drive had not been given the attention it deserves and that there is, consequently, a great lack of reliable information on which a new design can safely be based. The scope of the society will cover the application of friction drive in all industries.

Among those at the meeting were representatives of various industries using friction drive in its different forms, a man from the United States Bureau of Standards and the representatives of several ball bearing companies.

It is expected that the society will be expanded and permanently organized at the next meeting, which is to be held at the plant of the Rockwood Manufacturing Co., Indianapolis, Ind., on Nov. 3. Two papers are to be read at this meeting: "The History of the Friction Drive and Friction Material," by W. D. Hamerstadt, a leading authority on the subject; and "A New Form of Friction Wheel," by C. A. S. Howlett.

All companies or engineers interested in friction materials, whether for brake linings, friction drives, hoist wheels, or in any capacity where the development of better materials for friction purposes is desired, are invited to communicate with the secretary of the society at 25 Branford Place, Newark, N. J.

Thirty Thousand-Horsepower Hydro Plant for Kentucky

Efforts that have been made for some time to get Congress to close to navigation the Dix River, a picturesque stream in central Kentucky, so that a dam and power house could be built upon it, have finally been successful, according to a recent announcement from the Dix River Power Co., a new corporation organized by Lewis Herrington and others of Kentucky. It is planned to build a dam 700 ft. wide and 235 ft.

high, and to build a hydro-electric plant of 30,000 hp. capacity to supply power to Louisville, Lexington and other near-by cities.

The dam will be about two miles above High Bridge on the Cincinnati Southern R.R., where the river runs through a deep gorge. The lake that will result from damming the river will be about 25 miles long and about a quarter of a mile wide, and is expected to be big enough to keep the plant operating at full capacity through the dry season.

It is estimated that the cost will be between $3,500,000 and $4,000,000. It is expected that work will be started before the end of 1921 and completed in about fifteen months.

Suggestions Sought for Massachusetts Elevator Regulations

A statement has been issued by John H. Plunkett, chairman of the Massachusetts Board of Elevator Regulations, asking for suggestions from inspectors of elevators, real estate owners, architects, engineers, elevator manufacturers, liability insurance companies and others who are interested, as to the changes that they may desire in the elevator and escalator regulations, which were approved by the Governor and Council on June 29, 1915, and are still in effect.

When all available information and suggestions are in hand a hearing will be held in the State House, at which all interested parties will be given an opportunity to express their views.

In the meantime suggestions should be addressed to the Board of Elevator Regulations, Department of Public Safety, 24 State House, Boston, Mass.

New Publications

Material Handling Cyclopedia. By Roy L. Wright and John G. Little. Published by the Simmons-Boardman Publishing Co., Woolworth Bldg., New York City. Cloth or leather, 11¼ by 8¼ in.; 850 pages; 1,500 illustrations. Price, cloth $10, leather $15.

A large book that aims to cover all the devices used for handling materials in all industries. Almost anyone reading it for the first time will be surprised at the great diversity of apparatus coming under the classification of material-handling machinery. The subject is, indeed, larger than is often supposed, and is well covered. The material is necessarily condensed, as in all cyclopedias, but the comparative narrowness of the field has enabled the editors to discuss each subject with greater thoroughness than is generally the case with a work of this kind. The book is divided into three principal parts: The Definition Section, covering about 150 pages; the Illustrated Text Section, covering about 430 pages; and the Catalog Section, given over to the manufacturers of material-handling machinery. The Definition Section is especially useful, serving not only its obvious purpose, but also as an index to the text and catalog sections. The Text Section covers the following subjects: Hoisting machinery; package-handling conveyors and elevators; loose material conveyors and elevators; conveying-machinery details; elevators; trackless transportation; industrial rail transportation; handling systems.

American Electrician's Hand-Book. By Terrell Croft. Published by McGraw-Hill Book Co., Inc., New York City, 1921. Size, 4 x 6½ in.; cloth; 823 pages; 854 illustrations. Price, $4.

Few technical books have met with such favor as the first edition of this handbook, which was first published in 1913. This, the second edition, has been greatly enlarged and revised to bring it up to date. Old material has been changed where necessary and new matter added to the extent that the new edition contains 144 pages more than the old and it has been modified to conform with the 1920 National Electrical Code requirements. The work is divided into six sections: Fundamentals: generators and motors; outside distribution; interior wiring; transformers; and electric lighting. In compiling this material, it has been the aim of the author to include only such information as will enable practical electrical men to select commercial electrical apparatus and material intelligently for the performance of a given service and to operate the equipment after it has been installed. Throughout the book complicated mathematics has been avoided, and where calculations are necessary to the solution of the problems practical examples are given and worked out in detail. Although no attempt has been made to treat of apparatus involving voltages above 2,400 volts, and the book was prepared primarily for men with little schooling, it nevertheless has a wide field of usefulness to the technically trained engineer, and needs no further recommendation other than the popularity it has enjoyed during the past eight years.

Obituary

L. C. Pettit, vice-president of the Hays School of Combustion, in Chicago, died suddenly not long ago. The business will continue as before in charge of R. C. Acers, president, who was associated with Mr. Pettit for a number of years.

Lloyd W. Chapman, industrial editor of the *Journal of Electricity and Western Industry*, San Francisco, died recently from a sudden attack of spinal meningitis. He was born in Massachusetts only 36 years ago, and had devoted himself largely to various kinds of chemical work up to the time of his appointment in February of this year to the staff of the *Journal*.

Personals

H. W. Townsend, previously district manager of the Aldrich Pump Co.'s Pittsburgh office, has returned to the main plant at Allentown, Pa., as works manager.

F. F. Boyd, previously vice-president and manager of the Providence Engineering Corporation, New York City, is now connected with the Ames Iron Works, also of New York City.

Earl F. Heimpel has resigned as chief engineer of the Edison Portland Cement Co., Stewartsville, N. J., to join the sales force of the M. J. Dougherty Co., piping fabricators and engineers, of Philadelphia.

J. M. Whitham, of Philadelphia, has been appointed to represent the city and Chamber of Commerce of Philadelphia in assisting a special light and power investigation committee of the Harrisburg Chamber of Commerce in a study of the local steam-heat situation.

Nelson G. Rask, for the last ten years connected with the Walworth Manufacturing Co., Boston, Mass., has resigned his position as general works superintendent of that company's Boston works and is now with the General Fire Extinguisher Co., Providence, R. I., as general works superintendent of its Warren, Ohio, plant.

Frank G. Whitney has resigned after fifteen years as superintendent of substations for the New York Central R.R. to become superintendent of the Dutch Point Power Station of the Hartford (Conn.) Electric Light Co. Mr. Whitney's fellow employees gave him a farewell banquet, at which they presented him with a watch and traveling bag.

Society Affairs

The American Society for Testing Materials will meet Oct. 28 and 29 in the rooms of the Providence Engineering Society.

The Engineers' Society of Western Pennsylvania will meet Oct. 25 to hear C. M. Stein, a French engineer, discuss "Heating Furnaces."

Metropolitan Section, A. S. M. E., will hold a "Get Acquainted Supper Dance," at 6 p.m., Nov. 1, in the Pennsylvania Hotel, New York City.

Philadelphia Section, A. I. S. E. E., will meet Nov. 5 to hear J. G. Corrin, of the Pittsburgh Transformer Co., speak on "Operation and Care of Power Transformers."

Buffalo Section, A. S. M. E., will meet at the Lafayette Hotel Nov. 2 for an address on "Progress in Mechanical engineering Research," by Prof. Arthur M. Greene, Jr., of Rensselaer Polytechnic Institute.

Hartford Branch, A. S. M. E., will meet Nov. 3 for dinner at the Bond Hotel, after which there will be addresses on "Relations of the A. S. M. E. to the Community" by Governor E. J. Lake and Mayor Brainerd.

The **Providence Engineering Society's** Power Section will meet Nov. 1 to hear the subject of "Manufacture and Application of Lubricating Oils" discussed by G. R. Rowland and W. F. Osborne, respectively supervising engineer and supervisor of manufacturers' development of the Texas Company.

New Britain Section, A. S. M. E. (recently organized) will meet Oct. 25 at the New Britain Club to hear National Secretary Calvin W. Rice speak on "Engineering Societies National and International and their Relation to Industry and Government." Prof. S. W. Dudley, of Sheffield Scientific School, will speak on the air brake.

Indianapolis Section, A. S. M. E., will hold a two-day professional session Oct. 28 and 29. Headquarters will be at the Claypool Hotel. The "Stopshok Wheel" for trucks and steam power for commercial vehicles will be discussed Friday, and on Saturday there will be an inspection trip through the engineering buildings of Purdue University.

Business Items

The Universal Crane Co., Elyria, Ohio, has appointed George L. Sawyer, formerly sales manager of material-handling machinery for Barber-Greene Co., as its New York representative, with offices at the Allied Machinery Center, 141 Centre St., New York City.

The Jeffrey Manufacturing Co., Columbus, Ohio, has announced the appointment of Homer W. Scott as the head of the Cleveland office, located at 437 Leader News Building. C. R. Heller is now in charge of the Buffalo office at 1108 Marine Trust Building.

Ransom & Anderson Co., Inc., has been organized by Lewis L. Ransom, Raymond S. Anderson and Frank W. Saunderson, formerly treasurer, secretary and engineering superintendent, respectively, of John R. Proctor, Inc. They will carry on a designing and construction practice with offices at 75 Montgomery St., Jersey City, N. J., and 163 Liberty St., New York City.

The Combustion Improvement Corporation, 217 Engineers' Building, Cleveland, Ohio, has secured the rights for marketing the Gradeca patent boiler control system recently developed by J. M. Wilson, formerly plant engineer with the Standard Parts Co., and has appointed Mr. Wilson as manager of the corporation.

The Allen-Sherman-Hoff Co., 510 Stock Exchange Building, Philadelphia, Pa., has been organized for the manufacture of "A-S-H" hand-operated and power-operated gates for use with hoppers of its own or other design. The officers are: President, M. C. Sherman, previously with the Sherman Engineering Co.; vice-president and chief engineer, L. P. Hoff, formerly with the Baker-Dunbar-Allen Sales Co.; secretary and treasurer, Frank B. Allen, also of the Baker-Dunbar-Allen Sales Co.

Trade Catalogs

The Taylor Machine Co., 25 East Jackson Blvd., Chicago, Ill., has written *Power* to the effect that a mistaken impression might be conveyed by a Trade Catalog notice in the Oct. 4 issue, in which the Taylor engine was described as being of the "semi-Diesel' type. The point is brought out that in the Taylor engine, although air injection of the fuel is not used, as in the Diesel type, ignition is effected by high compression pressure, instead of by contact with hot surfaces, as in the conventional semi-Diesel type.

FUEL PRICES

BITUMINOUS COAL

The following table shows the trend of the spot steam market in various coals (mine-run bases, f.o.b. mines):

Coal	Market Quoting	Oct. 10, 1921	Oct. 17, 1921
Pool 1,	New York	$3.15	$3.15@3.35
Pocahontas	Columbus	2.75	2.40@2.85
Clearfield	Boston	1.95	1.75@2.15
Somerset	Boston	1.85	1.60@2.15
Pittsburgh	Pittsburgh	2.20	2.20@2.25
Kanawha	Columbus	1.95	1.90@2.20
Hocking	Columbus	2.00	1.90@2.15
Pittsburgh No. 8	Cleveland	2.20	2.10@2.20
Franklin, Ill.	Chicago	2.70	2.40@3.25
Central, Ill.	Chicago	2.25	1.75@2.75
Ind. 4th Vein	Chicago	2.55	2.25@2.75
Standard	St. Louis	1.85	1.75
West Ky.	Louisville	2.25	2.00@2.60
Big Seam	Birmingham	2.15	2.00@2.30
S. E. Ky.	Louisville	2.20	2.25@2.35

New York—On Oct. 19, Port Arthur light oil 22@25 deg. Baumé, 5½c. per gal. 30@35 deg., 7c. per gal. f.o.b. Bayonne, N. J.

Chicago—Oct. 17, for 24@28 deg. Baumé, 75@85c. per bbl.; 32@36 deg. 2½@2¾c. per gal. in tank cars f.o.b. Oklahoma refinery, or freight adjusted.

Pittsburgh—On Oct. 17, f.o.b. refinery; Pennsylvania, 36@40 deg., 4¾@5¼c. Oklahoma, 24@30 deg., $1.00 per bbl.; gas oil, 32@34 deg., 3½@3¾c. per gal., 36@38 deg., 3¼@3⅝c. 38@40 deg., 3⅞@4c.

St. Louis—Oct. 15, prices f.o.b. cars, tank lots; 24@26 deg. Baumé, 90c. per bbl.; 26@28c. deg. $1.00; 28@30 deg. $1.10; 32@34 deg., 3½c. per gal.

Philadelphia—On Oct. 15, 26@28 deg. Baumé Oklahoma, 60c. per bbl.; 30@34 deg., Oklahoma (group 3) 80c. per bbl.; 16@20 deg. Seaboard, 3½c. per gal.

Cincinnati — Oct. 17, for 26@30 deg. Baumé, 5c.; Diesel, 34@40 deg., 5½c. per gal.

Cleveland — Oct. 17, for 22@28 deg. Baumé, 4½c. per gal.

New Construction

PROPOSED WORK

Mass., Boston—O'Brien Bros., West 4th St., South Boston, are having plans prepared for a 4 story, 51 x 170 ft. factory. About $125,000. Dow, Harlow & Kimball, 101 Tremont St., Archts.

Conn., Waterbury—The Y. M. C. A., 136 West Main St., plans to build a 4 story, Y. M. C. A. building on West Main St. About $400,000. Architect not announced.

N. Y., Brooklyn—Goetz Co., Livingston St., will soon award the contract for a 10 story warehouse and office building on Livingston St. About $750,000. Ballinger Co., 47 West 34th St., New York City, Archts and Engrs.

N. Y., Brooklyn—Wykoff Heights Hospital, Wykoff Ave., plans to build a 5 story addition to hospital. About $300,000. Architect not selected.

N. Y., Buffalo — The American Grain & Feed Corp., 303 Chamber of Commerce, is having plans prepared for two elevators, flour mill, feed mill and warehouse, etc. About $400,000. L. R. Veatch, 428 Pratt St., Engr.

N. Y., New York—The Commonwealth Hotel Constr. Co., 18 East 41st St., has had plans prepared for a 30 story hotel on 7th Ave. and Broadway, 55th and 56th Sts. About $10,000,000. Starrett & Van Vleck, 8 West 40th St. and King & Campbell, 36 West 40th St., Archts.

N. Y., New York—E. DeRosa, Archt. and Engr., 110 West 40th St., is preparing plans for a theater on Burnside Ave. between Jerome and Walton Aves. for Coleman Bros. About $600,000.

N. Y., New York—N. J. Hayes, Comr. of Water Supply, Room 2351 Municipal Bldg., will receive bids until Oct. 28 for removing old settings, tubes, etc., from two Sterling boilers and furnishing and setting new tubes at the 98th St. Pumping Station.

N. Y., New York—The Ogden Amusement Co., c/o E. DeRosa, Archt., 110 West 40th St., is having plans prepared for a theater on Ogden Ave. About $400,000.

N. Y., New York—H. O. B. Realty Co., W. R. Harvey, Pres., c/o J. Boyland, Archt., 120 East Fordham Rd., is having plans prepared for a 5 story, 100 x 100 ft. apartment on 177th St., near St. Nicholas Ave. About $250,000.

N. Y., New York—The Shamokin Realty Corp., 609 West 48th St., is having plans prepared for a 15 story, 100 x 105 ft. apartment on 7th Ave. and 57th St. About $1,300,000. H. B. Mulliken, 609 West 48th St., Pres. and Archt.

N. Y., Onondaga Valley—The Bd. Educ., R. T. Anderson, Pres., will receive bids until Oct. 27 for a 2 story school including a steam heating system. About $300,000. M. L. King, Snow Bldg., Syracuse, Archt. and Engr.

N. Y., Troy—Fitzgerald Bros. Brewing Co., Ruer St., are having plans prepared for a cold storage building on River St. About $100,000. Ophuls, Hill & McCreery, 112 West 42d St., New York City, Archts. and Engrs.

Pa., Johnstown—The Peris Soap Products Co., South Sheridan St., A. Peris, Pres., plans to build a 3 story, 80 x 320 ft. soap factory on South Sheridan St. About $150,000.

Pa., Philadelphia—The city plans to build an addition to hospital on 34th and Pine St. About $780,000. P. B. Sinkler, City hall, Archt.

Pa., Wayne—Radnor Township, c/o J. C. Egbert, Wayne, is having plans prepared for a 3 story high school on Lancaster Ave. and Wayne St. About $250,000. C. H. Richards, 608 Chestnut St., Phila., Archt.

Va., Bristol—S. G. Keller, City Mgr., Bristol, Va., and G. P. Biedleman, Comr. Pub. Improvements, Bristol, Tenn., are having plans prepared for improvements to joint water supply and also individual water supplies for both cities to include filtration, pumping, reservoir capacity and enlargement of pipe lines. Norton, Bird & Whitman, Munsey Bldg., Baltimore, Md., engrs.

Va., Norfolk — Anheuser-Busch Co., Brooke Ave., had plans prepared for alterations and an addition to ice plant. About $250,000. Ophuls, Hill & McCreery, 112 West 42d St., New York City, Archts.

N. C., Fayetteville—The state is having plans prepared for several buildings for Negro State Normal School to include power and refrigeration plants. Total cost, $200,000. Stiles Dixon, Fayetteville, and W. G. Rogers, Charlotte Trust Bldg., Charlotte Associated Archts.

N. C., Pilot Mountain—The city plans to vote Nov. 3 on $40,000 bond issue for developing power on Ararat River. J. F. Kirkman, Mayor.

N. C., Wilmington—Carter's Production Wks., 210 South Water St., O. Carter, Purch. Agt., is in the market for one 5 to 10 kw. dynamo and switchboard to match.

Miss., Centreville—The city, c/o C. C. Germany, plans to install additional equipment to electric light plant. A bond issue of $25,000 was voted for the project.

O., Cleveland—The Bd. Educ., East 6th St. and Rockwell Ave., W. R. McCormack, Archt., will receive bids until Nov. 7 for a steam heating plant for the school building on East 116th St. and Collett Ave. About $150,000.

O., Cleveland—The city received bids for installing a steam boiler plant for the new public hall (now under construction) from Chappel, Warren Co., St. Clair Ave., $81,700; and Smith & Obey, Carnegie Ave., $87,400.

O., Dayton—The University of Dayton, J. A. Tetzlaff, Pres., plans to build a 4 story, 100 x 200 ft. dormitory building on the University grounds. About $275,000. Architect not selected.

O., Kingston—The city is having plans prepared for water works system, pumping station, etc. About $48,000. Jennigs, Lawrence Co., Hartman Bldg., Columbus, Engrs.

Mich., Ypsilanti—The city will receive bids until Oct. 28 for a 1 story, 29 x 37 ft. pumping station including one 750 gal. per min. pump, against 225 ft. head, one 1,000 gal. per min. against 225 ft. head and one 1,500 gal. per min. against 225 ft. head. Hoad & Decker, Ann Arbor, Engrs.

Ill., Chicago—D. Olmsted, 1496 Marlo Ave., is having plans prepared for an 8 story apartment hotel on North State and Goethe Sts. About $2,000,000. H. L. Stevens & Co., 30 North Michigan Ave., Archts. and Engrs.

Ill., Elgin—The Elgin Watch Co., c/o C. H. Hulbird, Pres., 10 South Wabash Ave., Chicago, is having plans prepared for a 4 story, 30 x 374 ft. watch factory including a steam heating system here. About $1,000,000. Postle & Fischer, 140 South Dearborn St., Chicago, Archts.

Ill., Sterling—The Bd. Educ. will receive bids until Oct. 31 for a 2 story, 100 x 200 ft. school. About $250,000. Ashby, Ashby & Schulze, 1511 West Jackson Blvd., Chicago, Archts.

Ill., Wheaton—The Wheaton College, c/o C. H. Blanchard, Pres., is having plans prepared for a group of college buildings including a power plant. Total cost about $3,000,000. Wolf, Sexton, Harper & Trueax, 7 West Madison St., Chicago, Archts.

Wis., Kaukauna—Valley Pulp Co., is having plans prepared for a pulp mill with 30 tons capacity. O'Keefe & Orbison, College Ave., Appleton, Archts. and Engrs.

Wis., Madison—The Madison Sanitarium, c/o P. L. Larson, Mgr., South Madison, plans to build a 3 story, 60 x 200 ft. sanitarium including a boiler house, etc. on South Madison St. About $150,000. Architect not selected.

Wis., Madison—The State Bd. of Control, c/o M. J. Tappins, Secy., Capitol Bldg., is having plans prepared for a 2 and 3 story, 40 x 100 ft. memorial hospital including a steam heating plant on Mendota St. About $350,000. A. Peabody, State Capitol Bldg., Archt.

Wis., Madison—The University of Wisconsin, c/o M. E. McCaffery, Secy., will soon receive bids for 350 hp. boilers, piping, etc., for heating plant. About $30,000. A. Peabody, Madison, Engr.

Wis., Milwaukee—The Sewerage Comn., J. H. Fowles, Secy., will receive bids until Nov. 11 for coal and ash handling equipment for boiler plant on Jones Island. T. C. Hatton, City Hall, Engr.

Wis., Soldiers Grove—The Peterson Estate Co., C. Paterson, Mgr., is having plans prepared for a 50 x 190 ft. addition to power plant including rebuilding dam, installing new water-wheel, generators and switchboard, etc. About $150,000. E. E. Dillon, Washington Bldg., Madison, Engr.

Wis., Soldiers Grove—The Soldiers Grove Elec. Co., T. Sine, Mgr., is receiving bids for extensions to electric distribution system; also meters, transformers, switchboards, etc. Estimated cost, $15,000. J. N. Callby, Washington Bldg., Madison, Engr.

Ia., Ashton—The city, c/o W. J. Johannes, Clk., is having plans prepared for water works system including a steel tank 50,000 gal. capacity, pumping equipment, etc. About $25,000. W. E. Buell & Co., Davids Bldg., Sioux City, Engrs.

Ia., Shell Rock—W. M. Roe, Waverly, representing a new company forming, plans a hydro-electric power development here. About $100,000. Holland, Ackerman & Hollans, 53 West Jackson Blvd., Chicago, Engrs.

Kan., McCracken—The city, c/o L. L. Ryan, Mgr., is having plans prepared for an addition to pumping station and reservoir, also laying new water mains, etc. About $55,000. Ruckel Eng. Co., Hutchinson, Engrs.

Mo., Kansas City—The Kansas City Stock Yards, care W. H. Weeks, Live Stock Exchange Bldg., is having plans prepared for a two-story, 300 x 870 ft., exposition building, including a steam heating system, on 23d St. and Trafficway. About $400,000. Architect not announced. Owner will build by day labor.

Mo., Kansas City—The Superior Ice Co., c/o A. L. Williams, Lee Bldg., is having plans prepared for a 3 story ice storage plant on 2nd and Main Sts. About $150,000. B. B. Ryan, care of owner, Archt.

Mo., Salisbury—The Salisbury Sanitary Ice & Supply Co. will soon award the contract for a 2 story ice plant. About $50,000. Black & Co., Salisbury, Archts.

Mo., St. Louis—Larkin & Pratt, 876-78 Arcade Bldg., are in the market for machinery for the Egyptian Syrup & Products Co. plant. Capacity 400 tons of cane per 24 hrs.

Tex., Austin—W. E. Dozier, 230 Austin Natl. Bank Bldg., is in the market for motors, up-right boilers, conveyors, concrete mixer, etc.

Tex., Dallas—The Commissioners Court, will receive bids until Oct. 31 for furnishing and erecting pumping equipment for the White Rock filteration plant. D. Morey, Jr., Praetorian Bldg., Engr. Former bids rejected. Noted July 26.

Tex., Edinburg—The city will receive bids soon for an electric light plant. H. E. Wilcox, City Engr.

Tex., Larado—F. W. Malley, Sec'y. Chamber of Commerce, is reciving bids for waterworks machinery including engines, pumping plants, pipe lines, etc., for city of 22,710 population. C. Frees, City Engr.

Okla., Marlow—The city is having plans prepared for an addition to power plant including the installation of two engine generator sets, switchboard, extensions to power house, etc. About $55,000. V. V. Long & Co., Colcord Bldg., Oklahoma City, Engrs.

Okla., Marlow—The city is having plans prepared for the installation of 4 miles of mains, a 250,000 gal reservoir, pumps and wells. About $60,000., V. V. Long & Co., Colcord Bldg., Oklahoma City, Engr.

Okla. Oklahoma City—The New State Ice Co., has had plans prepared for an ice plant. About $300,000. Ophuls, Hill & McCreery, 112 West 42d St., New York City, Archts.

Col., Denver—The Federal Reserve Bank, 10th Dist., R. A. Long Bldg., has purchased a site and plans to build a bank on 18th and Curtis Sts. Cost between $500,000 and $1,000,000. Architect not selected.

N. Mex., Fort Baynard—J. A. Wetmore, Supervising Archt., Washington, D. C., will receive bids until Nov. 3 for the installation of complete mechanical equipment for Infirmary, Central heating plant, power plant and outside service at the U. S. Public Health Service Hospital No. 55.

Wash., Seattle—The Bd. of Pub. Wks. received bids for a tunnel for the Gorge Creek plant of the Skagit River power development from R. C. Storrie & Co., Crocker Bldg., San Francisco, Cal., $2,203,865; the Puget Sound Bridge & Dredging Co., Central Bldg., $2,332,570; and the Grant Smith Co., Henry Bldg., $2,476,840 Noted Oct. 11.

Cal., San Diego—The Bureau of Yards and Docks, Navy Dept., Wash., D. C., plans to install cold storage and refrigerator equipment in the Naval Hospital here. Spec. 4543.

Que. Montreal — The Administrative Comn., L. O. Pion, chn., City Hall, is receiving bids for electrically operated pump for McTarish reservoir with capacity of 12,000,000 gal. About $16,000.

Ont., Ottawa—The Ottawa Collegiate Bd. 7 Monkland Ave., will soon receive bids for a high school including a steam heating system on Cryster Ave. About $750,000. J. A. Ewart, Jackson Bldg., Bank St., Archt.

Ont., Uxbridge—The town of Uxbridge is having plans prepared for a water works system including pump house, centrifugal pumps, etc. About $60,000. James, Proctor & Redfern, 36 Toronto St., Toronto, Engrs.

Ont., Watford—The council, c/o N. Herbert plans to build a hydro-electric lighting and power distribution system for Warwick township. About $50,000. Engineer not selected.

CONTRACTS AWARDED

R. I., Providence—The city has awarded the contract for a heating and ventilating system in the proposed 3 story high school on Pond St. to the Grinnell Co., 275 West Exchange St., $50,000.

Mass., Springfield—The City Property Comm. has awarded the contract for a heating and ventilating system in the proposed 4 story junior high school on State St. to Wyckoff & Lloyd Co., 35 Worthington St., $72,500. Noted Oct. 4.

N. Y., Buffalo—The city, Municipal Bldg., has awarded the contract for furnishing and installing 3 high pressure steam driven centrifugal pumps at Col. Francis Ward Pumping station to A. J. Abels Co., Inc., Iroquois Bldg., $20,870.

N. Y., New York—The Hillside Building Corp., c/o G. F. Pelham, Archt., 200 West 72d St., will build a 5 story apartment on Nagle Ave. About $250,000. Owner will build by day labor.

N. J., Lake Denmark—The Bureau of Yards and Docks, Navy Dept., Wash., D. C., has awarded the contract for improvements to power plant and fire protections to Lord Constr. Co., 105 West 40th St., New York City, $28,384. Spec. 4501. Noted Aug. 9.

Pa., Philadelphia—The Forest Laundry Co. has awarded the contract for a 4 story, 48 x 52 ft. boiler plant and a 1 story, 32 x 50 ft. laundry at 1704 North Fawn St. to G. Kessler Constr. Co., Drexel Bldg. About $30,000.

Pa., Pittsburgh—The North Pole Ice Co., 1218 West Carson St., has awarded the contract for a 7 story, 160 x 192 ft. ice plant on Carson St. to J. F. Love, Arrott Bldg. About $400,000.

Pa., Pittsburgh—The Union Ice Co., 124-26 West Ohio St., has awarded the contract for a 1 story, 65 x 128 ft. ice storage plant on Beaver Ave. to Rose & Fisher, 821 Pennsylvania Ave. About $70,000.

W., Va., Elkins—The city, has awarded the contract for pumping and filteration plant to the Concrete Steel Bridge Co., Clarksburg, $57,135; filter and piping equipment to the New York Continental Jewell Co., Nutley, N. J., $18,100; and pumps, motors and electrical equipments, DeLaval pumps to the Dravo-Doyle Co., Diamond Bank Bldg., Pittsburgh, Pa., $9,471. Noted Oct. 4.

Mich., Detroit—The Beaubien Ice & Coal Co., 4205 West Jefferson Ave., has awarded the contract for a 1 story ice plant on Baker and Porter Sts. to Pipe & Munnecke Marquette Bldg. About $40,000.

Wis., Stevens Point—The Stevens Point Hotel Co., has awraded the contract for a 5 story hotel to the Immel Constr. Co., 200 North Main St., Fond-du-lac. About $300,000. Noted Feb. 8.

Tex., Austin — The city, W. D. Yett, Mayor, has awarded the contract for a 70 x 90 ft. boiler house and 13 x 190 ft. concrete stack, to A. Mundt, 812 West 6th St., $36,000.

Tex., Gainesville—The Lone Star Gas Co. has awarded the contract for a 1 story, 40 x 80 ft. boiler house to the Austin Co., 16112 Euclid Ave., Cleveland, O. About $15,000.

Tex., Kerrville — The State American Legion, c/o S. B. Cowell, Chn., Austin, has awarded the contract for a 4 story hospital, here to A. E. Johnson Constr. Co., Waco., $256,862. A steam heating system will be installed.

Cal., Long Beach—Munholland & Co., 104 Pacific Ave., has awarded the contract for a 9 story apartment on Chestnut Pl. and Windsor Way, to Wallace, Bush & Skedmore Co., Los Angeles Railway Bldg., Los Angeles. About $300,000. A steam heating system and refrigerating plant will be installed.

Ont., Kingston — The Queens University and Kingston Hospital Bd. have awarded the contract for a central heating plant to P. McCoy, 37 Beverly St. About $125,000. Noted March 22.